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ALPINE LICHENS OF WESTERN UNITED STATES AND ADJACENT CANADA
I. THE MACROLICHENS

HENRY A. IMSHAUG[1, 2]

The objectives of this study are (1) to prepare a catalogue of all lichens found in alpine areas in western United States and adjacent Canada, (2) to prepare keys which will enable other workers (not necessarily lichenologists) to identify alpine lichens and therefore permit them to utilize the lichens in their own studies, (3) to prepare maps illustrating the alpine distribution of each species and (4) to analyze these distribution patterns and relate them to environmental and historic factors. The fulfillment of these objectives would answer many questions that have long been of interest to those concerned with the arctic flora. Lynge (1934) especially

[1] Contribution no. 57-8 from the Department of Botany and Plant Pathology, Michigan State University, East Lansing, Mich.

[2] The extensive field work involved in this study would not have been possible without the very generous financial support received from various sources and it is a pleasure to acknowledge this assistance at this time. The initial field work (1948, 1950) was financed by the University Herbarium of the University of Michigan, and I am indebted to Dr. E. B. Mains and Dr. A. H. Smith for their efforts in obtaining the necessary funds and their constant encouragement throughout my studies. I am also grateful to the University of Michigan for the receipt of a Horace H. Rackham Postdoctoral Fellowship which permitted a year of herbarium study at the University of Michigan and Harvard University. A grant (no. 1413) from the Penrose Fund of the American Philosophical Society permitted field work throughout the southern Rocky Mountains in 1952. This grant was supplemented by funds from the Chicago Natural History Museum, and I am most grateful to Dr. Francis Drouet for his interest in this project. Grants from the National Science Foundation (G943 and G2333) permitted field work in the Cascades, Sierra Nevada and Intermontane Region. The second grant (G2333) also made it possible to compare specimens in several herbaria and assemble the material for publication. The cost of publication has been met in part through this grant.

has lamented the lack of information concerning the lichens of the Rocky Mountains.

The data obtained in this study will be presented in four parts. The species themselves can be conveniently divided into three groups and each group will be treated in a separate part: the macrolichens (PART I), the non-saxicolous microlichens (PART II), and the saxicolous microlichens (PART III). PART IV will contain the ecologic and phytogeographic considerations.

In the present paper, keys are given for 84 species of foliose and fruticose lichens and the known alpine distribution of each species is plotted on maps 2-85. Many species have taxonomic or nomenclatural discussions. Three new taxa are described in *Stereocaulon*, *Umbilicaria* and *Dactylina*. Four nomenclatural changes are proposed in *Stereocaulon* and *Umbilicaria*.

HISTORICAL SURVEY

There has been no publication devoted primarily to alpine lichens in any part of western America, and the few papers on alpine ecology refer only incidentally to a few species of lichens. Reports dealing with collections from areas within western America, however, give a few references to alpine records, as do certain generic revisions and taxonomic studies. Most accounts, however, do not give enough data concerning the precise localities or habitats of the collections. In presenting this review, therefore, I am including only references where it is reasonably certain that the collections reported are actually from alpine areas. Since only occasionally does the author use the word alpine I have relied primarily on the altitudinal data given and my own field experience. It should be noted in this connection that the word alpine is interpreted in various ways by different authors. This will be discussed in detail in Part IV but it should be noted at this time that throughout this work *the word alpine refers only to those areas above the krummholz; i.e.*, above the upper limit of the forest, no matter how severe the conditions limiting its development.

The actual species mentioned in the following papers will be referred to in the taxonomic sections, and their names are, therefore, omitted from this review.

CHARLES CHRISTOPHER PARRY is apparently the first to have collected alpine lichens in the area under consideration. On his initial collecting trip to Colorado, in 1861, he made his base camp at the head waters of South Clear Creek and from there made journeys into the high country. It was on this trip that he named Torrey Peak, Gray Peak and Mt. Engelmann. A brief account of the region may be found in Parry (1862). The only published locality for an alpine lichen collection, however, is "alpine ridges east of Middle Park" (Tuckerman, 1862). Parry visited Colorado

again in 1862 and this time was accompanied by ELIHU HALL and J. P. HARBOUR. Gray (1863) has commented briefly on this expedition. Although their itinerary is vague it appears that their alpine lichens also came from the Clear Creek drainage. It is known, however, that Hall and Harbour visited Mt. Breckenridge in Summit County as well as the Hoosier Pass region. A few alpine lichen records from the 1861 and 1862 trips have been found in Tuckerman (1866a, b) and Willey (1874). The collections are now in the Farlow Herbarium of Harvard University.

ELIHU HALL later collected in Oregon and Tuckerman (1882) has cited a number of species collected by him in 1871 from the alpine region of Mt. Hood.

FERDINAND VANDEVEER HAYDEN, a geologist, began exploring the west in 1853 and in common with many scientists of the time his interests extended to all branches of science including botany. In 1867 he led the first United States Geological and Geographical Survey of the Territories, commonly referred to as the Hayden Survey. The 1872 survey began in Utah and JOHN MERLE COULTER joined the party as assistant geologist. Hayden, however, was so impressed by the young man's plant collections that he appointed Coulter botanist of the expedition. When the survey was divided into two parties Coulter proceeded to the Teton Range (Wyoming) and Hayden to the Yellowstone Valley. The only published alpine lichen record from the 1872 Hayden Survey is an *Umbilicaria* collected in the Teton Range at 12000 ft. (Willey, 1873).[3] Coulter was also a member of the 1873 Hayden Survey to Colorado and collected alpine lichens on Horse Shoe Mt. (Park County), Mt. La Plata (Chaffee County) and White House Mt. (Ouray County). These collections are now in the United States National Museum, Smithsonian Institution. It was this expedition which resulted in Porter and Coulter's "Synopsis of the flora of Colorado." The section on lichens in this synopsis was contributed by Willey (1874), but many of the alpine collections cited were those of Parry and Hall some years earlier.

EUGENE PENARD, a protozoologist from Switzerland, collected in the Front Range of Colorado in 1891[4] and the lichens were reported by Müller (1895). Only one species, from Bald Mt. in Boulder County, was alpine.

WILHELM NIKOLAUS SUKSDORF resided in Bingen, Washington, for many years and also owned a farm in Falcon Valley near

[3] The collector is erroneously cited as Hayden in Llano (1950, p. 95).
[4] Not 1892 as mentioned in the title of Müller's report. See Ewan (1950) for data concerning the actual year of Penard's visit to Colorado.

the southeastern base of Mt. Adams. Howard (1955) has published a list of Suksdorf's lichen collections, and several are reported from elevations of 7000 ft. or higher on Mt. Adams. These were collected from 1882 to 1902. Many records, however, are without altitudinal or ecological data. Suksdorf's collections are now in the herbarium of the State College of Washington.

JOHN MACOUN traveled widely in Canada and in the years 1884 to 1904 made several trips to the Canadian Rocky Mountains. The earlier collections are included in his *Catalogue of Canadian Plants* (Macoun, 1902), but it is difficult to cite any definite alpine records because he used the term alpine very loosely. A few species, however, are unquestionably from alpine areas on Sulphur Mt. and Mt. Niblock in the Banff and Lake Louise areas. The lichens were determined by G. K. Merrill and have been widely distributed.

WILSON P. HARRIS collected lichens in western Montana during the summer of 1901 under the auspices of The New York Botanical Garden. These were determined by his mother, Carolyn Wilson Harris (Mrs. Isaac Harris), and recorded in Harris and Harris (1904). From the data given in their publication, however, it is doubtful if any of the lichens were collected in alpine areas. The highest elevation recorded was 7750 ft. on Silloway Mt. This list formed the basis of a report by Jones (1910), and although he used the term alpine (without elevations), I cannot accept these as definite alpine records, and they are not included in this paper.

BRUCE FINK collected lichens in alpine areas (Mt. St. Piran and Mt. Fairview) in the Canadian Rocky Mountains, and his specimens are now in the herbarium of the University of Michigan. Although a complete list of these collections has not been published, a few notes are given in his popular account of the trip (Fink, 1907) and in a later paper on distribution (Fink, 1919).

ALBERT WILLIAM CHRISTIAN THEODORE HERRE has collected alpine lichens on the summit of Mt. Rose, Nevada, and on Mt. Baker, Washington. He published a list (1913) of the Mt. Rose lichens and referred to the lichen community on the summit as a *Gyrophora reticulata* formation. The Mt. Baker lichens are included in his 1917 and 1943 papers. As a result of my own field work around Mt. Baker, however, I can only consider those records of 7000 ft. or more in elevation as alpine.

BROTHER GERFROY ARSÈNE (Arsène Gustave Joseph Brouard) collected extensively in the Sangre de Cristo Range of northern New Mexico, including alpine areas on Lake Peak and Baldy Peak in August 1926. These collections were recorded by Bouly

de Lesdain (1932, 1942), but elevations were not given, and so it is not certain which of the species cited from Lake and Baldy Peaks were actually alpine.

Whitfield (1933) reported on an ecological study of the Pikes Peak region and listed a few lichens from above timberline on Pikes Peak, Colorado.

GRACE HOWARD has collected extensively in the state of Washington and in her preliminary report on the lichen flora of the state (Howard, 1937), she cited several lichens from alpine areas in the Cascade Mountains, collected primarily by herself from 1928 to 1934. These specimens are in the herbarium of Wellesley College. Additional alpine records are in her later work (Howard, 1950), including two species collected by THEODORE CHRISTIAN FRYE on the summit of Mt. Olympus in the Olympic Mountains.

WALTER KIENER has collected extensively in the Rocky Mountain National Park of Colorado and especially on Long's Peak. He has, however, reported only on the genus *Peltigera* (Kiener, 1939).

Hedrick (1942) reported many species from the Olympic Mountains of Washington, collected by ALEXANDER HANCHETT SMITH. No specimens, however, were cited above 6000 ft., and so I cannot include any of these records as alpine. The collections are in the herbarium of the University of Michigan.

Herre (1950) reported on some of WILLIAM BRIDGE COOKE's collections from alpine areas on Mt. Shasta, California. No lichens, however, were found at elevations above 12336 ft.

Hayward (1952) described the alpine biotic communities in the Uinta Mountains, Utah. Only one lichen, however, is reported.

In recent years SAM SHUSHAN and WILLIAM WEBER have collected extensively in Colorado and have begun a series of papers on the lichen flora of the state. In the first paper (Weber & Shushan, 1955), the genera *Cetraria, Cornicularia, Dactylina* and *Thamnolia* are treated with keys, photographs and specimen citations. Many alpine records are given for these genera.

Bliss (1956) has reported on an ecological study comparing an arctic tundra in Alaska with an alpine tundra in the Medicine Bow Mountains of southern Wyoming. The only lichen reported by Bliss was *Thamnolia vermicularis* (Sw.) Schaer., but the area he studied was not above the krummholz.

In addition to the above references a number of taxonomic papers include an occasional alpine record and they are referred to in the text. These papers are Berry (1941), Evans (1952a, b), Herre (1911, 1946), Llano (1950), Lynge (1933), Magnusson

(1929, 1932, 1933, 1935, 1947) and Thomson (1950). The collectors of these specimens include, in addition to the above mentioned collectors, many noted American naturalists, *e.g.*, DARROW, FOSTER, FRYE, GRANT, and PLITT. Members of the National Park Service have also contributed specimens from alpine areas within our national parks.

ALPINE AREAS STUDIED

The bulk of the material reported in this paper has been collected by the author, and the localities visited are listed below according to the physiographic classification of Fenneman (1931). In order to conserve space in the citation of specimens the locality data has been reduced to a minimum, and the reader is referred to the following list for additional data.

Included in this list of localities are several areas (28-35) visited by DR. I. M. LAMB in 1951. The lichens collected are in the herbarium of the National Museum of Canada, and I am indebted to Dr. I. M. Lamb and Dr. H. Crum for the privilege of studying this material and including it in this study.

Also, I have had the opportunity to study the collections of Dr. Shushan and Dr. Weber. They have not only collected extensively in Colorado but they have also received much material from other recent collectors in western United States, and their herbarium is an important source of distributional data. Included in their collections are many specimens collected by DR. EILIF DAHL on his visit to Colorado. The localities visited by Shushan, Weber *et al.* are not included in the following list although their specimens are cited in the taxonomic section.

PACIFIC MOUNTAIN SYSTEM

PACIFIC BORDER PROVINCE. *Olympic Mountains (Washington)*. (1) Obstruction Point, 6450 ft., Clallam Co., T. 28 N., R. 5 W., Sect. 18 (47° 55′ N., 123° 23′ W.). (2) Moose Lake Trail, 6200-6500 ft., Clallam Co., T. 28 N., R. 5 W., Sect. 18 (47° 55′ N., 123° 22′ W.).

CASCADE-SIERRA MOUNTAINS PROVINCE. *Northern Cascade Mountains (Washington)*. (3) Summit of Windy Peak, 8345 ft., Okanogan Range, Okanogan Co., T. 40 N., R. 23 E., Sect. 33 (48° 55′ N., 119° 58′ W.). (4) Summit of Tiffany Mt., 8275 ft., Okanogan Range, Okanogan Co., T. 37 N., R. 23 E., Sect. 27 (48° 40′ N., 119° 56′ W.). (5) Summit of Slate Peak, 7488 ft., border of Okanogan and Whatcom Cos., T. 37 N., R. 17 E., Sect. 1 (48° 45′ N., 120° 41′ W.). (6) Summit of Pugh Mt., 7150 ft., Snohomish Co., T. 31 N., R 11 E., Sect. 27 (48° 09′ N., 121° 22′ W.). *Middle Cascade Mountains (Washington and Oregon)*. (7) Burroughs Mt., 6500-7400 ft., Mt. Rainier National Park, Pierce Co., Washington (46° 55′ N., 121° 41′ W.). (8) Mt. Fremont, 7100 ft. to summit at 7200 ft., Mt. Rainier National Park, Pierce Co., Washington (46° 55′ N., 121° 41′ W.). (9) Anvil Rock, 9600 ft., Mt. Rainier, Mt. Rainier National Park, Pierce Co., Washington

(46° 50′ N., 121° 44′ W.). (10) Ridge from North Sister to Middle Sister, 9200 ft., border of Deschutes and Lane Cos., Oregon, T. 16 S., R. 8 E., Sect. 28 (44° 09′ N., 121° 48′ W.). *Southern Cascade Mountains (California)*. (11) Mt. Shasta, 13800 ft. to summit at 14162 ft., Siskiyou Co., T. 41 N., R. 3 W., Sections 9 & 16 (41° 25′ N., 122° 11′ W.). (12) Summit of Lassen Peak, 10466 ft., Shasta Co. (40° 29′ N., 121° 30′ W.). *Sierra Nevada (Nevada and California)*. (13) Summit of Mt. Rose, 10775 ft., Carson Range, Washoe Co., Nevada, T. 17 N., R. 18 E., Sect. 13 (39° 20′ N., 119° 55′ W.). (14) Summit of peak along ridge from Sonora Pass to Leavitt Peak, 11225 ft., border of Tuolumne and Mono Cos., California, T. 5 N., R. 21 E., Sect 10 (38° 18′ N., 119° 38′ W.). (15) Summit of Mt. Dana, 13000-13050 ft., Yosemite National Park, Tuolumne Co., California, T. 1 N., R. 25 E., Sect. 33 (37° 54′ N., 119° 13′ W.). (16) Summit of Mammoth Peak, 12225 ft., Yosemite National Park, Tuolumne Co., California, T. 1 S., R. 25 E., Sect. 7 (37° 52′ N., 119° 16′ W.). (17) Ridge above Parker Pass, 11800 ft., Yosemite National Park, Tuolumne Co., California, T. 1 S., R. 25 E., Sect. 15 (37° 50′ N., 119° 12′ W.). (18) Mono Pass, 12000 ft., border of Fresno and Inyo Cos., California, T. 6 S., R. 29 E., Sect. 11 (37° 25′ N., 118° 46′ W.). (19) Above Piute Pass, 12000 ft., border of Fresno and Inyo Cos., California, T. 8 S., R. 30 E., Sect. 16 (37° 15′ N., 118° 41′ W.). (20) Bishop Pass, 12000 ft., border of Fresno and Inyo Cos., California, T. 10 S., R. 31 E., Sect. 1 (37° 07′ N., 118° 33′ W.). (21) Kearsarge Pass, 11823 ft., border of Fresno and Inyo Cos., California, T. 13 S., R. 33 E., Sect. 27 (36° 46′ N., 118° 23′ W.). (22) Summit of Mt. Whitney, 14495 ft., border of Tulare and Inyo Cos., California, T. 16 S., R. 34 E., Sections 4 & 5 (36° 35′ N., 118° 17′ W.).

Intermontane Plateaus

Columbia Plateaus Province. *Wallowa Mountains (Oregon)*. (23) Summit of Eagle Cap, 9675 ft., border of Union and Wallowa Cos., T. 5 S., R. 44 E., Sect. 3 (45° 10′ N., 117° 18′ W.).

Basin and Range Province. *Snake Range (Nevada)*. (24) Summit of Wheeler Peak, 13061 ft., White Pine Co., T. 13 N., R. 68 E., Sect. 14 (38° 59′ N., 114° 19′ W.). *Spring Mountains (Nevada)*. (25) Summit of Charleston Peak, 11910 ft., Clark Co., T. 19 S., R. 56 E., Sect. 28 (36° 16′ N., 115° 42′ W.).

Colorado Plateaus Province. *La Sal Mountains (Utah)*. (26) Summit of Mt. Mellenthin, 12890 ft., San Juan Co., T. 27 S., R. 24 E., Sect. 11 (38° 28′ N., 109° 14′ W.). *San Francisco Mountains (Arizona)*. (27) Summit of Agassiz Peak, 12340 ft., Coconino Co., 35° 20′ N., 111° 41′ W.).

Rocky Mountain System

Northern Rocky Mountains Province. *Bow Range (Alberta)*.[5] (28) Mt. St. Piran, near Lake Louise, 2895 m. (29) Redoubt Mt., near Lake Louise, 2830 m. (30) Little Mt. Richardson, near Lake Louise, 2865 m. (31) Silvertip Mt., near Lake Louise, 2860 m. (32) Eagle Mt., near Lake Louise, 2900 m. (33) Quartz Hill, near Sunshine Lodge, 2800 m. (34) Twin Cairns Mt., near Sunshine Lodge, 2800 m. (35) Cita-

[5] Localities 28-35 are alpine areas visited by Dr. I. M. Lamb, and the data are from his notes. In the citation of specimens Dr. Lamb's collection numbers are preceded by his name in order to distinguish them from the author's numbers from the same region. Both sets of numbers, by coincidence, are in the 6000's.

del Peak, near Sunshine Lodge, 2850 m. (36) near Victoria Glacier, above Lake Louise (51° 24′ N., 116° 16′ W.). (37) Mt. Rundle, near Banff. *Lewis Range* (*Montana: Glacier National Park*). (38) Mt. Henkel, 6800 ft., Glacier Co. (48° 49′ N., 113° 41′ W.). (39) Basin between Appekunny Mt. and Altyn Peak, 6000 ft., Glacier Co. (48° 49′ N., 113° 39′ W.). (40) Altyn Peak, 7500 ft., Glacier Co., (48° 49′ N., 113° 40′ W.). (41) Appekunny Mt., 8500 ft., Glacier Co. (48° 49′ N., 113° 38′ W.). (42) Swiftcurrent Pass, 7000 ft., border of Glacier and Flathead Cos. (48° 47′ N., 113° 46′ W.). (43) Swiftcurrent Mt., 8200 ft. to summit at 8300 ft., border of Glacier and Flathead Cos. (48° 47′ N., 113° 46′ W.). (44) Garden Wall above Grinnell Glacier, 7900-8000 ft., border of Glacier and Flathead Cos. (48° 46′ N., 113° 45′ W.). (45) Piegan Pass, 8000 ft., Glacier Co. (48° 43′ N., 113° 41′ W.). (46) Siyeh Pass, 8200 ft., Glacier Co. (48° 43′ N., 113° 38′ W.). (47) Goat Mt., 6500 ft. to summit at 8816 ft., Glacier Co. (48° 42′ N., 113° 35′ W.). (48) Reynolds Mt., 7700 ft., border of Flathead and Glacier Cos. (48° 41′ N., 113° 43′ W.). (49) Comeau Pass, Sperry Glacier, 8250 ft., Flathead Co. (48° 38′ N., 113° 46′ W.). (50) Dawson Pass, 7500-8000 ft., border of Flathead and Glacier Cos. (48° 29′ N., 113° 28′ W.). (51) Scenic Point, 7000 ft. to summit at 7625 ft., Glacier Co. (48° 29′ N., 113° 20′ W.). *Flint Creek Range* (*Montana*). (52) Summit of Mt. Powell, 10213 ft., Powell Co., T. 7 N., R. 11 W., Sect. 21 (46° 21′ N., 113° 00′ W.). *Lost River* (*or Hawley*) *Range* (*Idaho*). (53) Bench below Leatherman Pass to somewhat above pass, 10000-11000 ft., Custer Co., T. 9 N., R. 23 E., Sect. 28 (44° 05′ N., 113° 45′ W.). *Pioneer Mountains* (*Idaho*). (54) Bench below Hyndman Pass to somewhat above pass, 10200-10750 ft., border of Custer and Blaine Cos., T. 5 N., R. 20 E. (43° 45′ N., 114° 08 ′ W.).

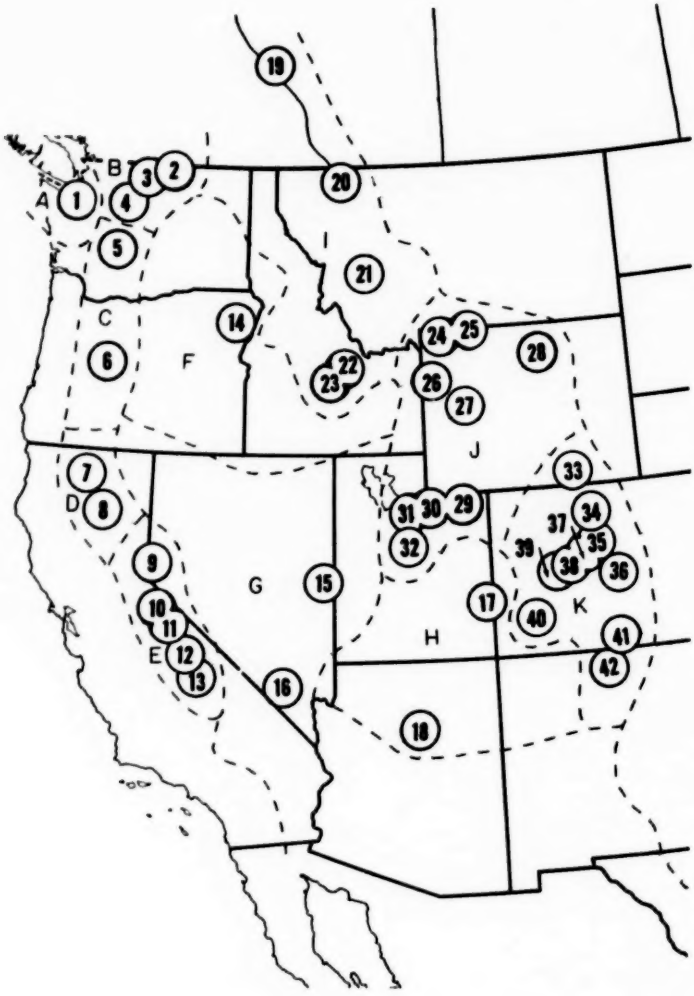
Middle Rocky Mountains Province. *Beartooth Range* (*Wyoming*). (55) Beartooth Pass, 11000 ft., Park Co. (44° 58′ N., 109° 26′ W.). *Washburn Range* (*Wyoming*). (56) Summit of Mt. Washburn, 10300 ft. (44° 48′ N., 110° 26′ W.). *Teton Range* (*Wyoming*). (57) Summit Divide, 10600 ft., Teton Co. (43° 48′ N., 110° 49′ W.). (58) Pinnacle above Surprise Lake, 9900 ft., Teton Co. (43° 44′ N., 110° 47′ W.). (59) Summit of Static Peak, 11294 ft., Teton Co. (43° 41′ N., 110° 49′ W.). *Wind River Range* (*Wyoming*). (60) Mt. Lester, 11700 ft., Sublette Co., T. 36 N., R. 107 W. (43° 03′ N., 109° 37′ W.). *Big Horn Mountains* (*Wyoming*). (61) Loaf Mt., 11000 ft., border of Big Horn and Johnson Cos., T. 49 N., R. 85 W. (44° 12′ N., 107° 04′ W.). *Uinta Mountains* (*Utah*). (62) Summit of Leidy Peak, 12013 ft., Uintah Co., T. 1 S., R. 19 E., Sect. 6 (40° 46′ N., 109° 50′ W.). (63) Summit of Marsh Peak, 12219 ft., Uintah Co., T. 1 S., R. 19 E., Sections 19 & 30 (40° 43′ N., 109° 50′ W.). (64) Summit of Bald Mt., 11300-11947 ft., border of Summit and Duchesne Cos., T. 4 N., R. 9 W., Sections 27 & 34 (40° 42′ N., 110° 54′ W.). (65) Summit of Murdock Mt., 11200 ft., Duchesne Co., T. 3 N., R. 9 W., Sect. 3 (40° 41′ N., 110° 53′ W.). *Wasatch Mountains* (*Utah*). (66) Summit of Mt. Baldy, 11049 ft., border of Salt Lake and Utah Cos., T. 3 S., R. 3 E., Sect. 8 (40° 34′ N., 111° 38′ W.). (67) Mt. Timpanogos, 10850 ft. to summit at 12000 ft., Utah Co., T. 5 S., R. 3 E., Sections 7 & 18 (40° 23′ N., 111° 39′ W.). (68) Summit of Mt. Nebo, 11871 ft., Juab Co., T. 11 S., R. 1 E., Sect. 36 (39° 49′ N., 111° 46′ W.).

Southern Rocky Mountains Province. *Medicine Bow Mountains* (*Wyoming*). (69) Summit of Medicine Bow Peak, 12005 ft., Albany Co.,

T. 16 N., R. 79 W., Sections 7 & 18 (41° 22′ N., 106° 19′ W.). *Front Range (Colorado)*. (70) Trail Ridge in Rocky Mountain National Park, 11800-11900 ft., Larimer Co. (40° 24′ N., 105° 43′ W.). (71) Mt. Evans, 11500 ft. to summit at 14260 ft., Clear Creek Co., T. 5 S., R. 74 W. (39° 36′ N., 105° 38′ W.). (72) Pikes Peak, 13000 ft. to summit at 14100 ft., El Paso Co. (38° 50′ N., 105° 03′ W.). *Park Range (Colorado)*. (73) Hoosier Ridge, 12800-13000 ft., border of Summit and Park Cos., T. 8 S., R. 77 W., Sections 8 & 17 (39° 22′ N., 106° 01′ W.). *Sawatch Mountains (Colorado)*. (74) Mt. Massive, 12750 ft. to summit at 14418 ft., Lake Co., T. 10 S., R. 81 W. (39° 11′ N., 106° 27′ W.). (75) Independence Pass and somewhat above, 12100-12900 ft., border of Lake and Pitkin Cos., T. 11 S., R. 82 W. (39° 07′ N., 106° 35′ W.). (76) Lake Pass, 12225 ft., border of Chaffee and Gunnison Cos., T. 12 S., R. 82 W., Sect 21 (39° 00′ N., 106° 33′ W.). (77) Ridge above Cottonwood Pass, 12250-12700 ft., border of Gunnison and Chaffee Cos., T. 14 S., R. 81 W., Sections 14 & 23 (38° 51′ N., 106° 28′ W.). (78) Cumberland Pass, 12000-12400 ft., Gunnison Co., T. 51 N., R. 4 E. (38° 41′ N., 106° 29′ W.). *Elk Mountains (Colorado)*. (79) Summit of Mt. Belleview, 12500 ft., border of Gunnison and Pitkin Cos., T. 12 S., R. 86 W., Sect. 17 (39° 01′ N., 107° 00′ W.). (80) East Maroon Pass, 11850 ft., border of Gunnison and Pitkin Cos., T. 12 S., R. 86 W., Sect. 13 (39° 01′ N., 106° 56′ W.). (81) Virginia Basin and Virginia Ridge, 11900-12000 ft., Gunnison Co., T. 12 S., R. 86 W., Sect. 26 (38° 59′ N., 106° 58′ W.). (82) Ridge of Avery Peak, 12300-12400 ft., Gunnison Co., T. 12 S., R. 86 W., Sect. 26 (38° 59′ N., 106° 58′ W.). (83) Ridge near summit of White Rock Mountain, 12800-13000 ft., Gunnison Co., T. 12 S., R. 85 W., Sect. 30 (38° 59′ N., 106° 56′ W.). (84) Gothic Mt., 12400 ft. to summit at 12646 ft., Gunnison Co., T. 13 S., R. 86 W., Sect. 4 (38° 57′ N., 107° 00′ W.). *San Juan Mountains (Colorado)*. (85) Blue Lake Pass, ca. 12500 ft., Ouray Co., T. 43 N., R. 8 W., Sections 7 & 18 (38° 00′ N., 107° 47′ W.). (86) Ridge between Engineer and Gravel Mts., 13000-13200 ft., border of San Juan and Hinsdale Cos., T. 43 N., R. 6 W., Sect. 30 (37° 56′ N., 107° 34′ W.). *San Miguel Mountains (Colorado)*. (87) Summit of Black Face, 12100 ft., border of San Miguel and Dolores Cos., T. 41 N., R. 10 W. (37° 50′ N., 107° 55′ W.). *Sangre de Cristo Range (Colorado and New Mexico)*. (88) Summit of West Spanish Peak, 13623 ft., border of Huerfano and Las Animas Cos., Colorado, T. 31 S., R. 68 W. (37° 23′ N., 105° 03′ W.). (89) Summit of Trinchera Peak, 13546 ft., junction of Costilla, Huerfano and Las Animas Cos., Colorado, T. 32 S., R. 70 W. (37° 18′ N., 105° 09′ W.). (90) Summit of Gold Hill, 12660 ft., Taos Co., New Mexico (36° 38′ N., 105° 28′ W.). (91) Summit of Wheeler Peak, 13151 ft., Taos Co., New Mexico (36° 33′ N., 105° 25′ W.).

Explanation of Maps

Map 1 is the base map used in plotting the alpine distributions shown in maps 2-85. Open circles in all maps indicate the location of alpine areas visited by the author. Closed circles in maps 2-85 indicate the occurrence of the species plotted. The species are either absent in localities represented by open circles or are of infrequent occurrence and were not seen.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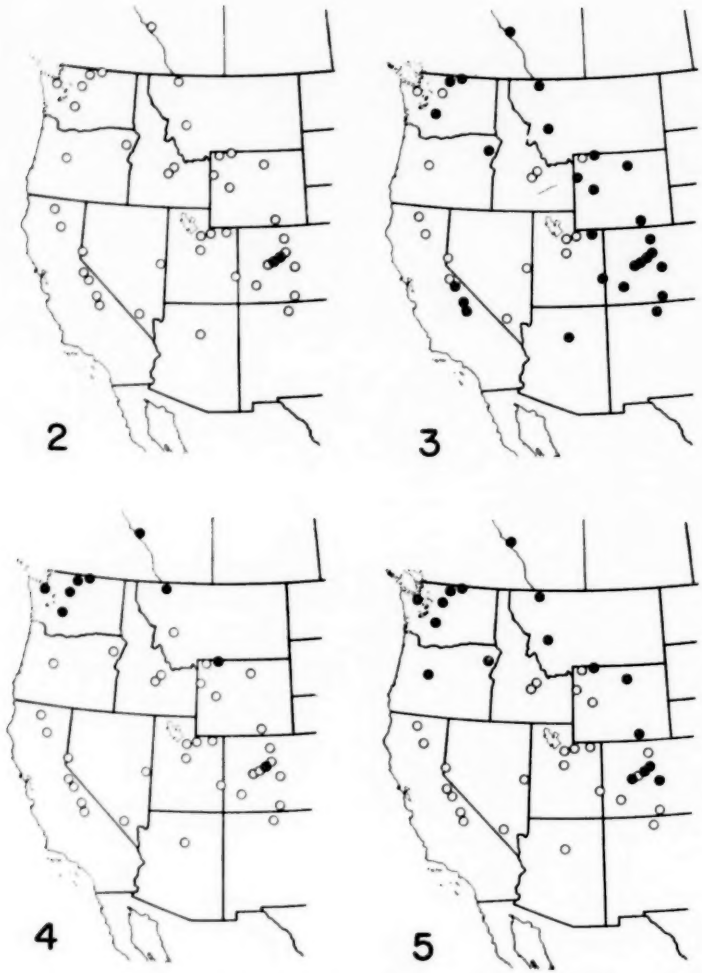
MAP. 1. Index map to the 42 major alpine areas studied. The numbers within the circles refer to the following key which identifies the 42 major alpine areas and gives the specific field station numbers for the precise localities studied in each major area. These field stations are identified in detail in the preceding section.

PACIFIC MOUNTAIN SYSTEM. 1. Olympic Mountains (stations 1 & 2). 2. Okanogan Range (stations 3 & 4). 3. Slate Peak (station 5). 4. Pugh Mt. (station 6). 5. Mt. Rainier National Park (stations 7-9). 6. Three Sisters (station 10). 7. Mt. Shasta (station 11). 8. Lassen Peak (station 12). 9. Mt. Rose, Carson Range (station 13). 10. Sonora Pass (station 14). 11. Yosemite National Park (stations 15-17). 12. Sierra Nevada (stations 18-20). 13. Sierra Nevada (stations 21 & 22).

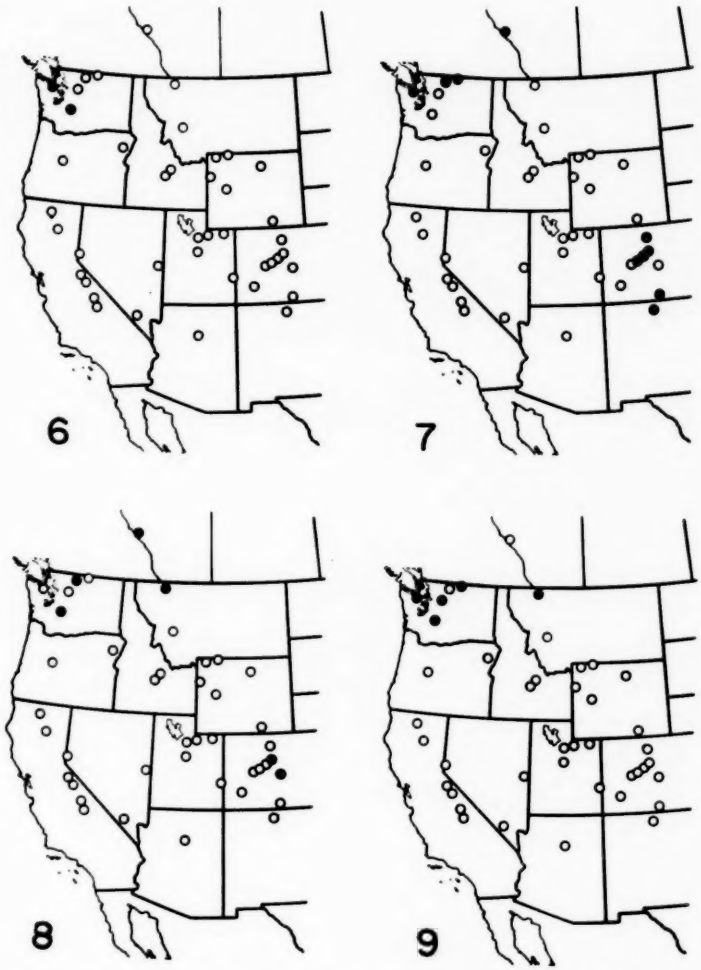
INTERMONTANE PLATEAUS. 14. Wallowa Mountains (station 23). 15. Wheeler Peak, Snake Range (station 24). 16. Charleston Peak, Spring Mountains (station 25). 17. La Sal Mountains (station 26). 18. San Francisco Mountains (station 27).

ROCKY MOUNTAIN SYSTEM. 19. Bow Range (stations 28-37). 20. Glacier National Park (stations 38-51). 21. Flint Creek Range (station 52). 22. Lost River Range (station 53). 23. Pioneer Mountains (station 54). 24. Beartooth Range (station 55). 25. Washburn Range (station 56). 26. Teton Range (stations 57-59). 27. Wind River Range (station 60). 28. Big Horn Mountains (station 61). 29. Uinta Range (stations 62 & 63). 30. Uinta Range (stations 64 & 65). 31. Wasatch Mountains (stations 66 & 67). 32. Wasatch Mountains (station 68). 33 Medicine Bow Mountains (station 69). 34. Rocky Mountain National Park (station 70). 35. Mt. Evans (station 71). 36. Pikes Peak (station 72). 37. Park Range (station 73). 38. Sawatch Range (stations 74-78). 39. Elk Mountains (stations 79-84). 40. San Juan and San Miguel Mountains (stations 85-87). 41. Sangre de Cristo Range (stations 88 & 89). 42. Sangre de Cristo Range (stations 90 & 91).

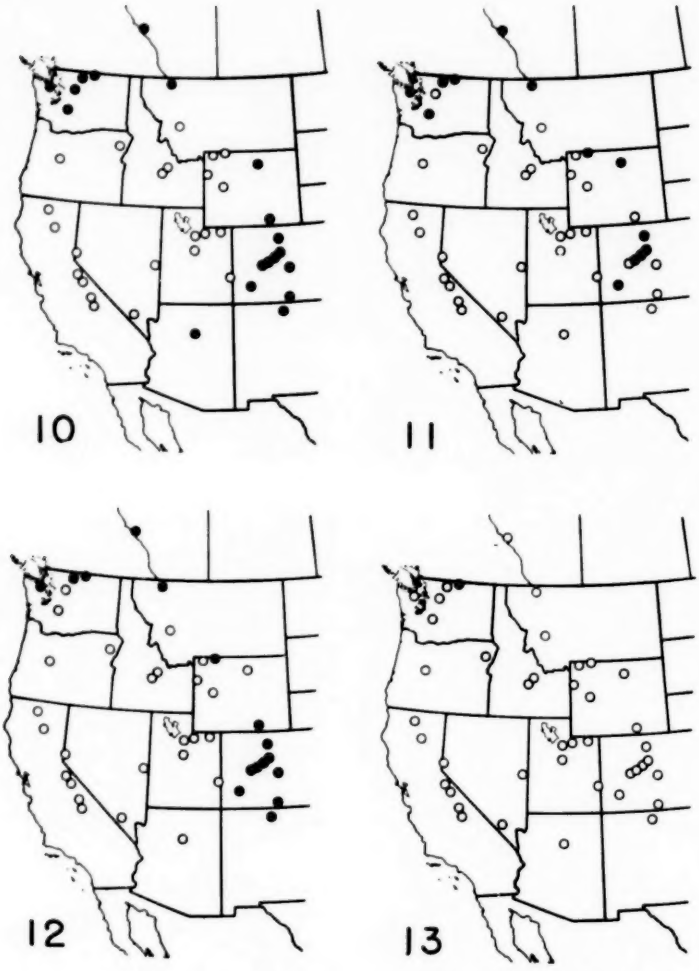
The 42 major alpine areas are listed in this paper according to the physiographic classification of Fenneman (1931). These groupings are identified on map 1 by the letters A-K: A. Olympic Mountains. B. Northern Cascade Mountains. C. Middle Cascade Mountains. D. Southern Cascade Mountains. E. Sierra Nevada. F. Columbia Plateaus Province. G. Basin and Range Province. H. Colorado Plateaus Province. I. Northern Rocky Mountains Province. J. Middle Rocky Mountains Province. K. Southern Rocky Mountains Province.



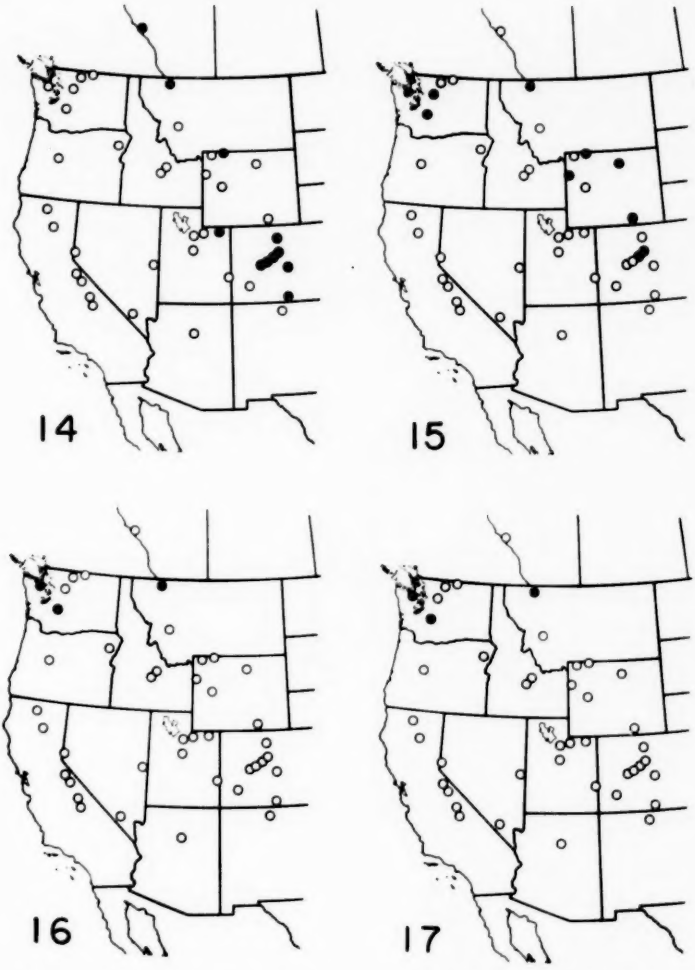
MAPS 2-5. Alpine distributions. 2. *Alectoria jubata*. 3. *Alectoria minuscula*. 4. *Alectoria nigricans*. 5. *Alectoria pubescens*.



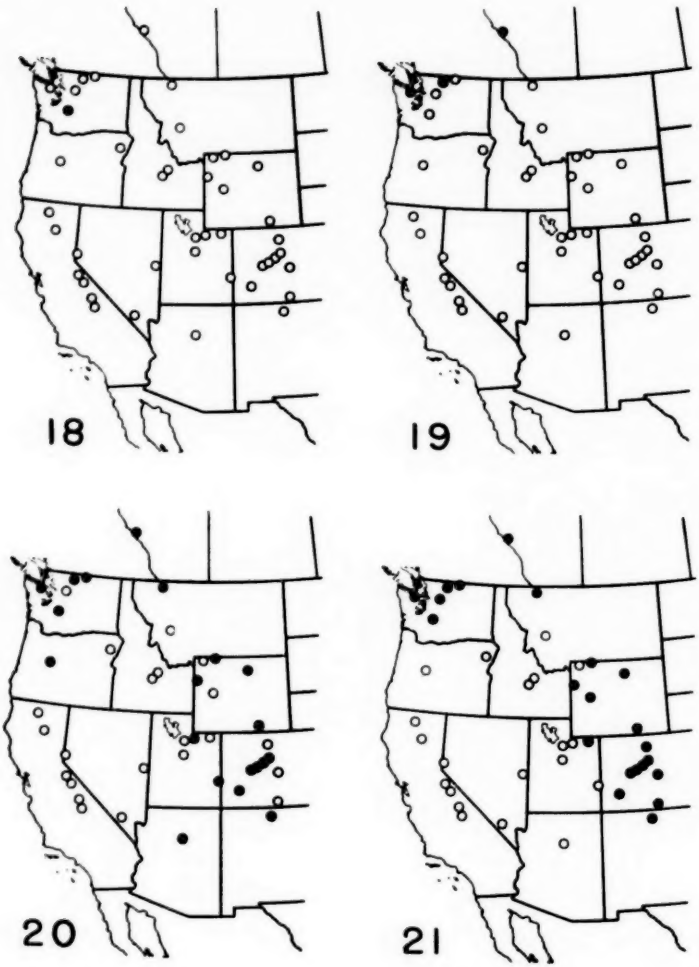
MAPS 6-9. Alpine distributions. 6. *Alectoria sarmentosa*. 7. *Cetraria cucullata*. 8. *Cetraria fahlunensis*. 9. *Cetraria hepatizon*.



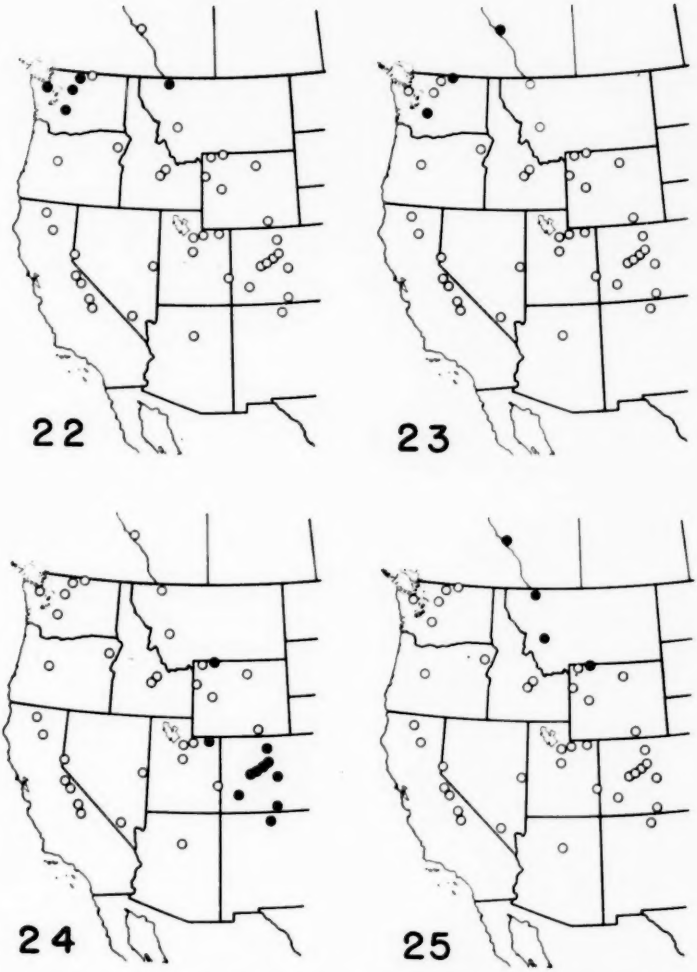
MAPS 10-13. Alpine distributions. 10. *Cetraria islandica* ssp. *crispa*. 11. *Cetraria islandica* ssp. *islandica*. 12. *Cetraria nivalis*. 13. *Cetraria pinastri*.



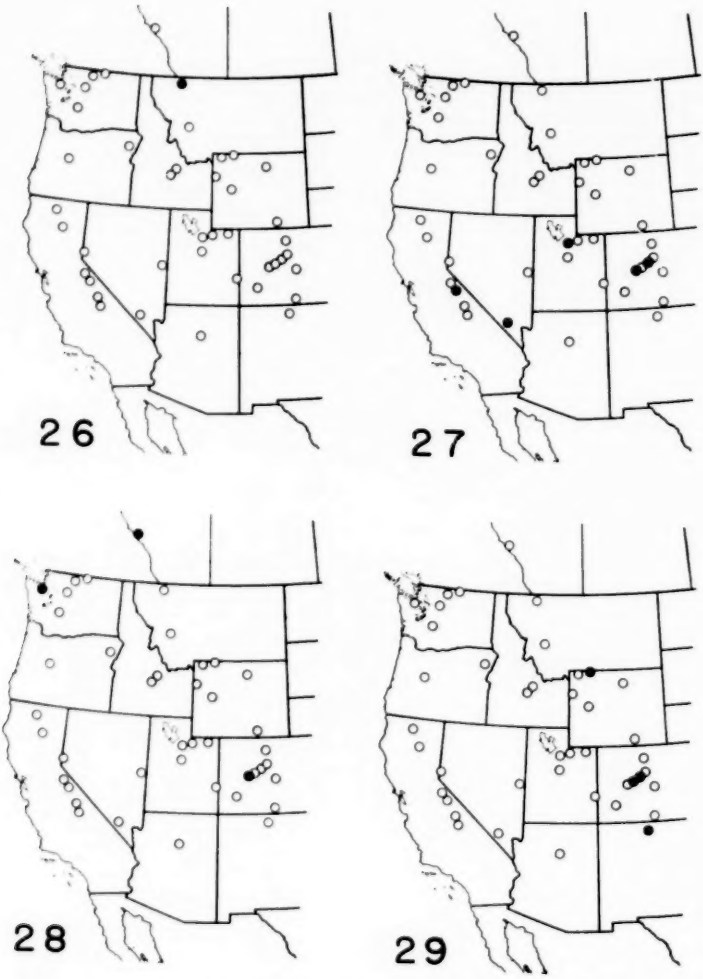
MAPS 14-17. Alpine distributions. 14. *Cetraria tilesii*. 15. *Cladonia coccifera*. 16. *Cladonia cariosa*. 17. *Cladonia ecmocyna*.



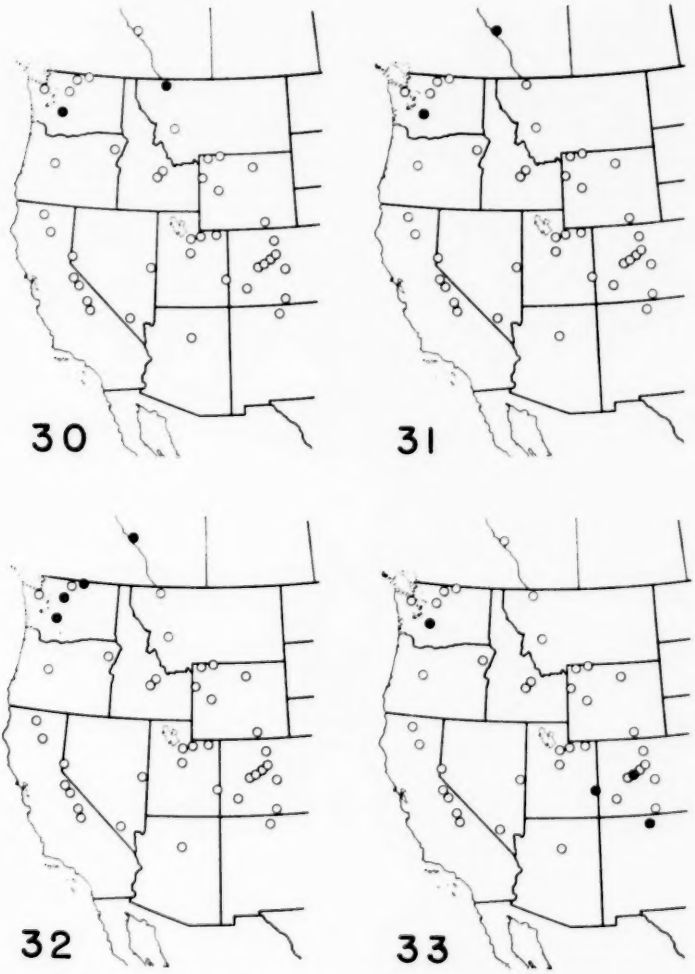
MAPS 18-21. Alpine distributions. 18. *Cladonia gracilis*. 19. *Cladonia mitis*. 20. *Cladonia pyxidata*. 21. *Cornicularia aculeata*.



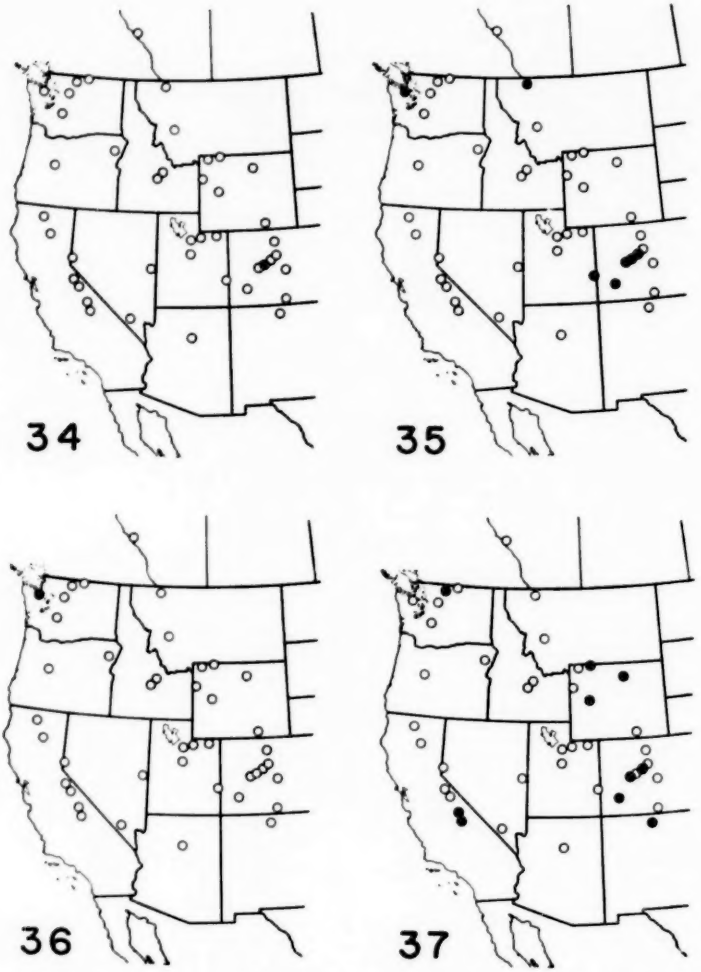
MAPS 22-25. Alpine distributions. *22. Cornicularia normoerica. 23. Dactylina arctica. 24. Dactylina madreporiformis. 25. Dactylina ramulosa.*



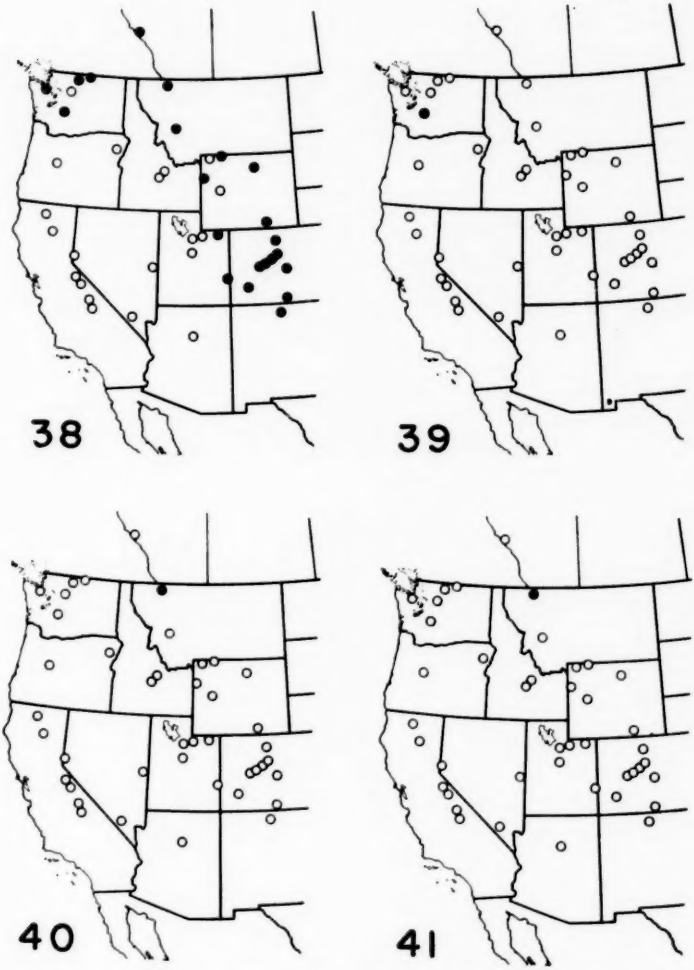
MAPS 26-29. Alpine distributions. 26. *Dermatocarpon intestiniforme*. 27. *Dermatocarpon miniatum*. 28. *Dermatocarpon reticulatum*. 29. *Evernia divaricata*.



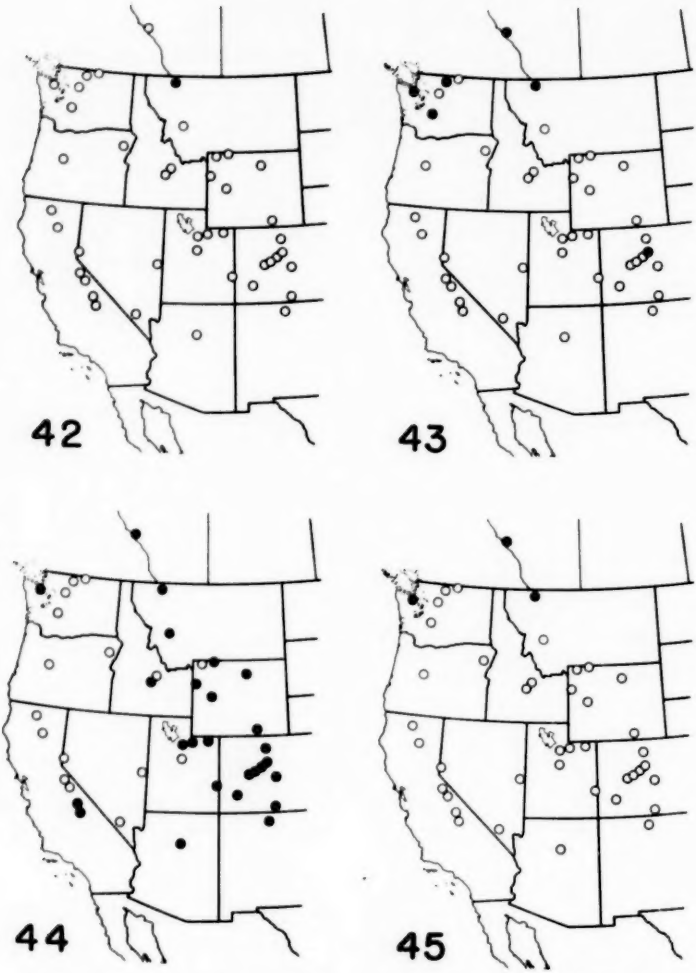
MAPS 30-33. Alpine distributions. 30. *Letharia vulpina*. 31. *Lobaria linita*. 32. *Parmelia alpicola*. 33. *Parmelia austerodes*.



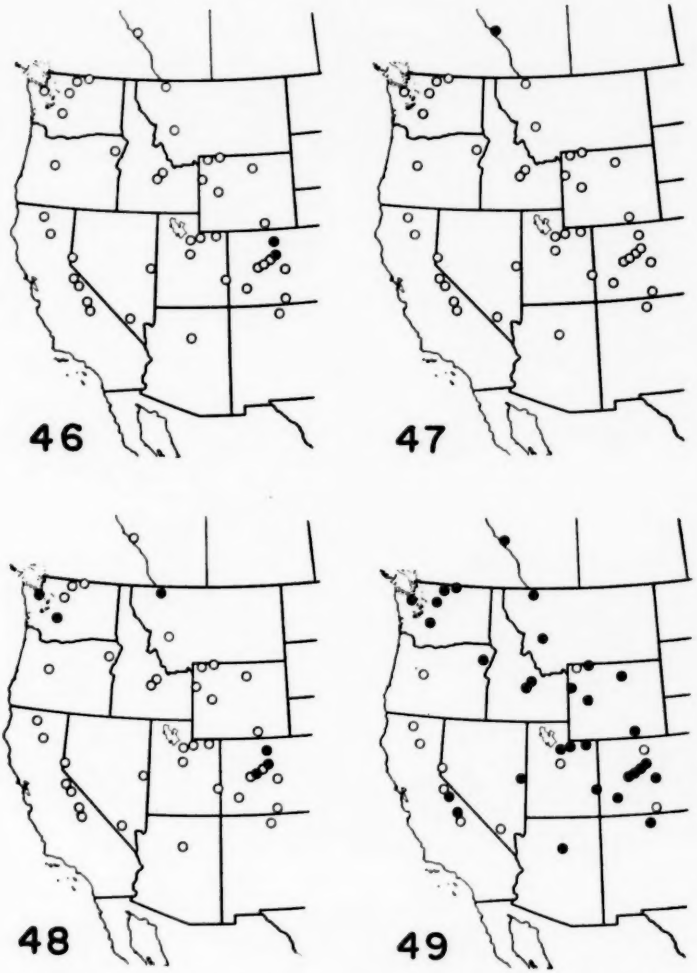
MAPS 34-37. Alpine distributions. 34. *Parmelia bitteri*. 35. *Parmelia disjuncta*. 36. *Parmelia enteromorpha*. 37. *Parmelia infumata*.



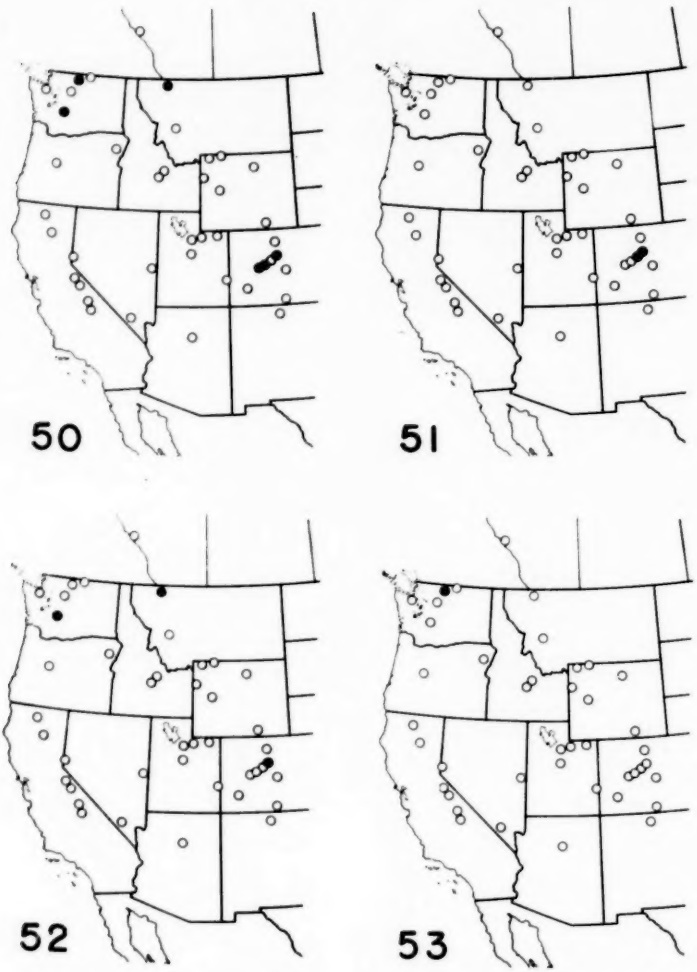
MAPS 38-41. Alpine distributions. 38. *Parmelia intestiniformis*. 39. *Parmelia omphalodes*. 40. *Parmelia panniformis*. 41. *Parmelia physodes*.



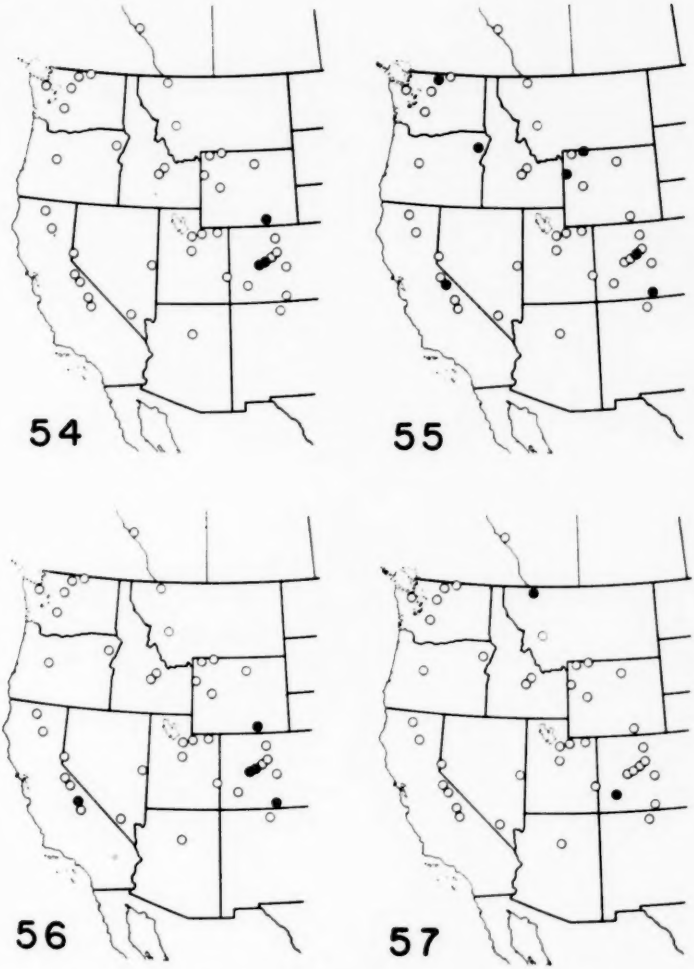
MAPS 42-45. Alpine distributions. 42. *Parmelia pulla*. 43. *Parmelia saxatilis*. 44. *Parmelia stenophylla*. 45. *Parmelia stygia*.



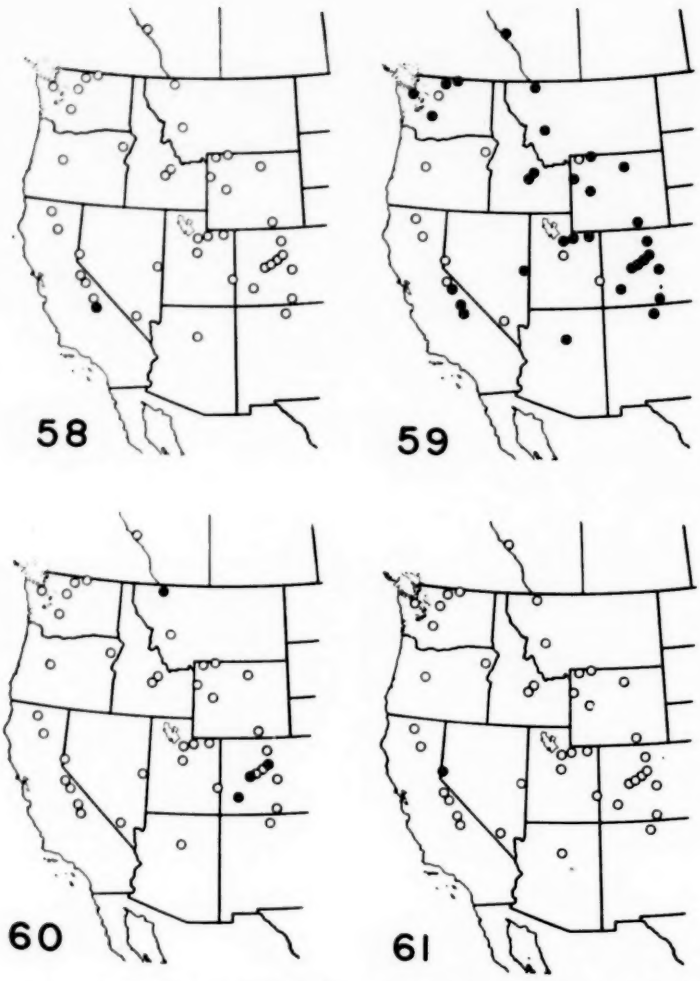
MAPS 46-49. Alpine distributions. 46. *Parmelia subobscura*. 47. *Parmelia sulcata*. 48. *Peltigera aphthosa*. 49. *Peltigera canina*.



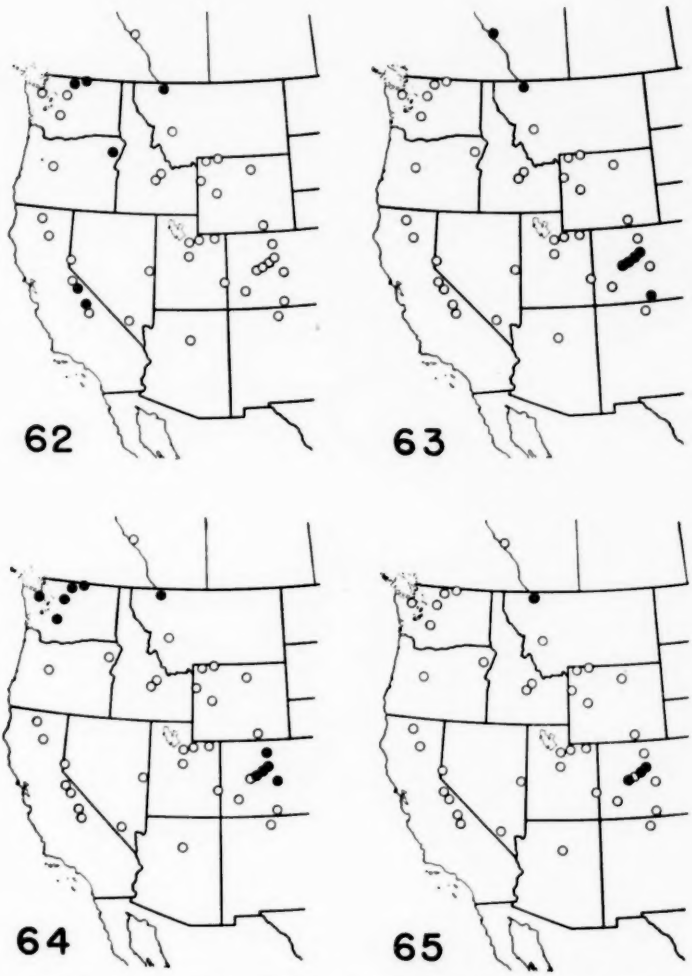
MAPS 50-53. Alpine distributions. 50. *Peltigera lepidophora*. 51. *Peltigera malacea*. 52. *Peltigera venosa*. 53. *Physcia aipolia*.



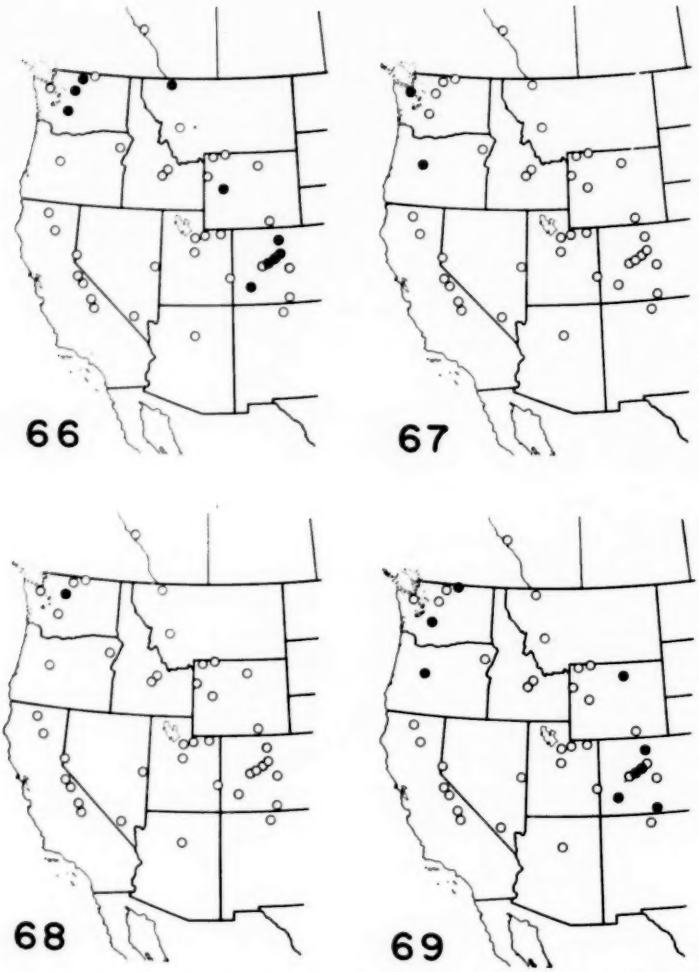
MAPS 54-57. Alpine distributions. 54. *Physcia caesia*. 55. *Physcia dubia*. 56. *Physcia intermedia*. 57. *Physcia lithotodes*.



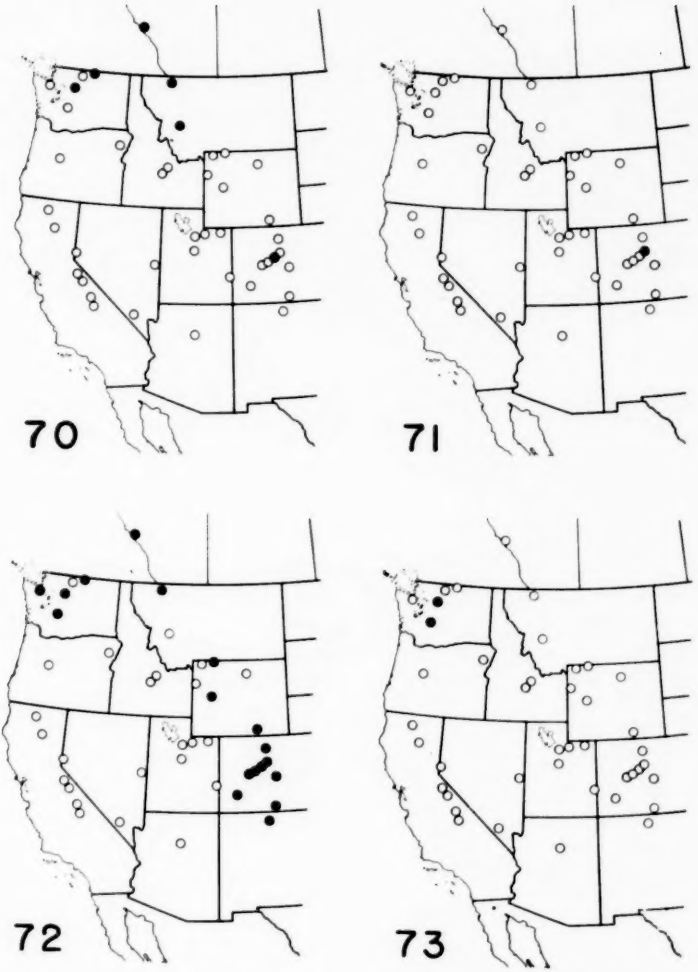
MAPS 58-61. Alpine distributions. 58. *Physcia melops*. 59. *Physcia muscigena*. 60. *Physcia sciastra*. 61. *Physcia stellaris*.



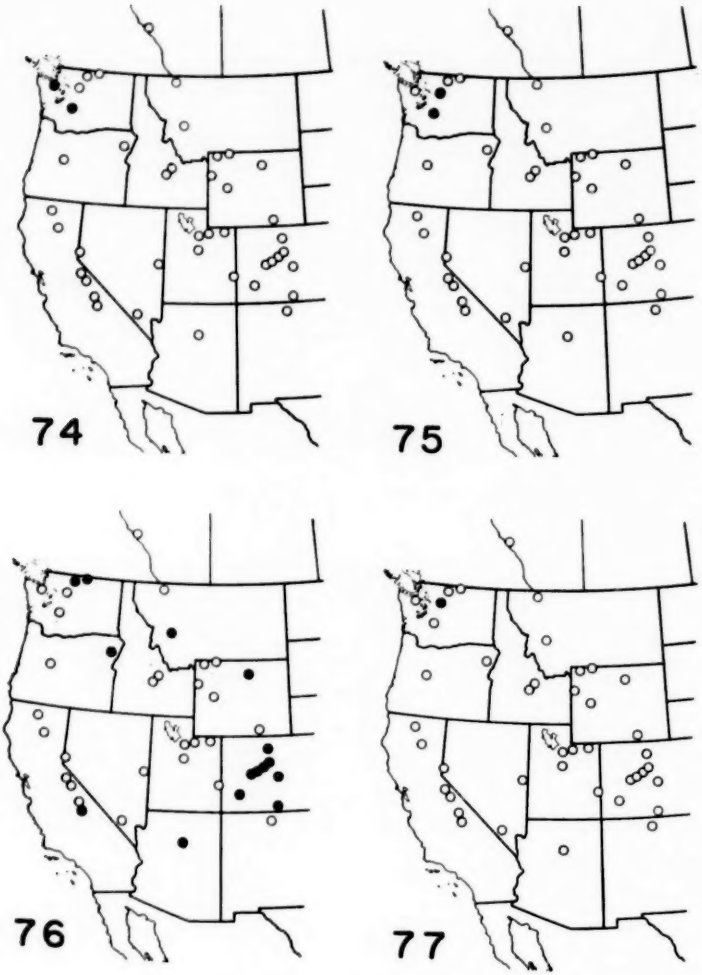
MAPS 62-65. Alpine distributions. *62. Physcia teretiuscula. 63. Solorina bispora. 64. Solorina crocea. 65. Solorina octospora.*



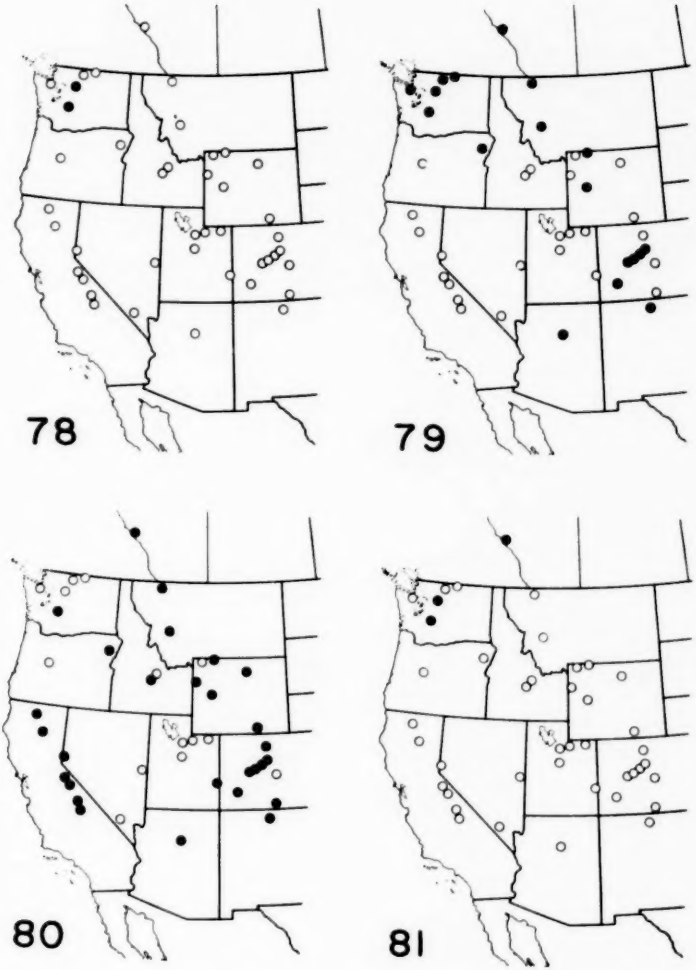
MAPS 66-69. Alpine distributions. 66. *Stereocaulon alpinum*. 67. *Stereocaulon botryosum*. 68. *Stereocaulon depreaultii*. 69. *Stereocaulon glareosum*.



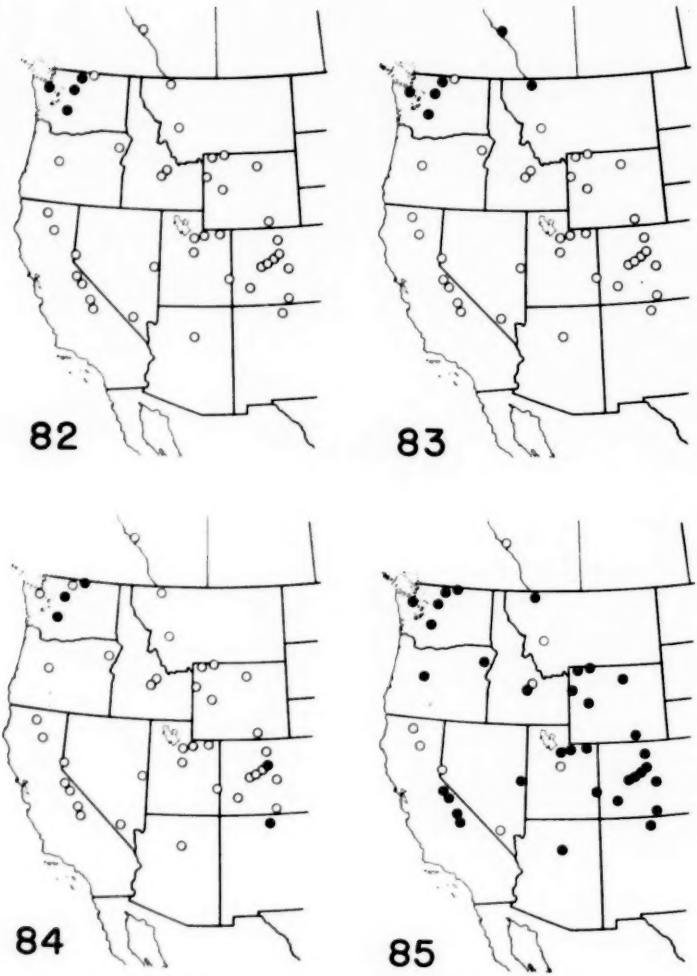
MAPS 70-73. Alpine distributions. 70. *Stereocaulon subalbicans*. 71. *Stereocaulon rivulorum*. 72. *Thamnolia vermicularis*. 73. *Umbilicaria angulata*.



MAPS 74-77. Alpine distributions. 74. *Umbilicaria coriacea*. 75. *Umbilicaria cylindrica*. 76. *Umbilicaria decussata*. 77. *Umbilicaria deusta*.



MAPS 78-81. Alpine distributions. 78. *Umbilicaria havaasii*. 79. *Umbilicaria hyperborea*. 80. *Umbilicaria krascheninnikovii*. 81. *Umbilicaria lambii*.



MAPS 82-85. Alpine distributions. 82. *Umbilicaria proboscidea*. 83. *Umbilicaria torrefacta*. 84. *Umbilicaria vellea*. 85. *Umbilicaria virginis*.

Location of Collections

All collections cited without a collector's name or without the symbol S are the collection numbers of the author and are distributed in herbaria as follows: 1-9865 and 16349-19181 in the University of Michigan (MICH[6]) with some duplicates at Michigan State University (MSC); 9866-12942 in the Chicago Natural History Museum (F) with duplicates at the University of Michigan and Michigan State University.

Dr. Lamb's collections from the Canadian Rocky Mountains are in the National Museum of Canada (CAN) with some duplicates at Michigan State University.

All numbers preceded with the letter S are the accession numbers of the University of Colorado Lichen Herbarium (COLO). They have been collected primarily by Dr. Sam Shushan and/or Dr. William Weber. Other collectors include Dr. Eilif Dahl and Dr. Walter Kiener.

Artificial Key to Alpine Genera of Macrolichens

Those who use this key must remember that it has been constructed in order to facilitate the identification of the alpine lichens of western United States and adjacent Canada. The characters used, therefore, may in some instances be valid only for the alpine species treated within this area.

1. Thallus foliose (with definite upper and lower surfaces) and ± appressed to substratum 2
1. Thallus fruticose (± terete in cross-section without definite upper and lower surfaces) and usually not appressed to substratum 14
2. Thallus umbilicate on rock, with one or more points of attachment 3
2. Thallus not umbilicate 4
3. Fruiting bodies are apothecia adnate on upper surface; rhizinae present or absent ..... *Umbilicaria*
3. Fruiting bodies are perithecia imbedded in thallus with only dark ostioles visible; rhizinae absent in alpine species ..... *Dermatocarpon*
4. Thallus discontinuous; composed of many individual squamules ... 5
4. Thallus continuous but deeply divided into laciniae 6
5. Algae of the thallus Chlorophyta; apothecia borne on upright podetia ..... *Cladonia*
5. Algae of the thallus Cyanophyta or Chlorophyta; no podetia ..... (see Part II)
6. Lower surface smooth (no tomentum and no rhizinae), but marginal spines or cilia may be present 7
6. Lower surface with tomentum or rhizinae 9

[6] The herbaria are referred to throughout this publication by the symbols recommended in Lanjou and Stafleu's "Index Herbariorum" (*Regnum Vegetabile* vol. 2).

7. Thallus inflated (thick); with medullary cavity or solid ..... *Parmelia* subg. Hypogymnia
7. Thallus not inflated (thin) 8
8. Algae of the thallus Chlorophyta; laciniae frequently with marginal spines or pycnidia ..... *Cetraria*
8. Algae of the thallus Cyanophyta; thallus ± inconspicuous ..... (see Part II)
9. Non-corticate below; veins or nerves frequently conspicuous; rhizinae present 10
9. Corticate below 11
10. Apothecia usually present and immersed in upper surface of laciniae, not marginal or terminal ..... *Solorina*
10. Apothecia frequently absent but always terminal on upper surface of lobes ..... *Peltigera*
11. Lower surface without rhizinae but with tomentum of hair-like hyphae and scattered naked areas ..... *Lobaria*
11. Lower surface with rhizinae but without tomentum 12
12. Thallus yellow or orange; KOH + (purple) ..... *Xanthoria*
12. Thallus gray or brown, rarely yellow-green; not KOH+ (purple) 13
13. Thallus usually large and coarse, frequently shiny, occasionally with yellow tints; spores colorless and non-septate ..... *Parmelia* subg. Parmelia
13. Thallus small and delicate (lobes and tips less than 2 mm.); upper surface dull, never with yellow tints, frequently pruinose; spores brown and one-septate ..... *Physcia*
14. Thallus white, ashy or gray 15
14. Thallus not white, ashy or gray 16
15. "Podetia" unbranched and hollow; no phyllocladia ..... *Thamnolia*
15. Pseudopodetia erect, branched and solid; phyllocladia and cephalodia common ..... *Stereocaulon*
16. Thallus brown to black 17
16. Thallus yellow or green 18
17. Cortex decomposed; *i.e.*, made up of indistinct hyphae irregularly branched and with terminal cell walls swollen into a gelatinous mass ..... *Cornicularia*
17. Cortex fibrous; *i.e.*, made up of long, sparingly branched hyphae lying parallel with the surface of the thallus ..... *Alectoria*
18. Thallus swollen, podetioid, hollow or with a very lax medulla; erect on soil ..... *Dactylina*
18. Thallus not swollen; on soil or rock 19
19. Filaments with one or more distinct, central cords 20
19. Filaments without any distinct central cord 21
20. One central cord; filaments black spotted; saxicolous ..... *Neuropogon*
20. Several cords; filaments not black spotted; saxicolous in alpine areas ..... *Letharia*
21. Filaments very irregular in section; thallus soft and flaccid with arachnoid axis and cottony medulla ..... *Evernia*
21. Filaments evenly terete 22
22. Cortex smooth; pseudocyphellae present ..... *Alectoria*
22. Cortex arachnoid; pseudocyphellae absent ..... *Cladonia*

DERMATOCARPACEAE

DERMATOCARPON

The only species of this genus treated in Part I are those belonging to the section Entosthelia (Wallr.) Stzbgr.

1. Thallus smooth or wrinkled below but not papillose 2
1. Thallus papillose below ..... *D. reticulatum*
2. Thallus polyphyllous; lobes ± convex with edges inrolled; spores up to 12 μ long with a length/breadth coefficient of ca. 1.5 ..... *D. intestiniforme*
2. Thallus monophyllous or polyphyllous; lobes not as above; spores up to 20 μ long with a length/breadth coefficient of ca. 2.0 ..... *D. miniatum*

1. DERMATOCARPON MINIATUM (L.) Mann, Lich. Bohem. obs. dispos. 66. 1825. *Lichen miniatus* L. Sp. Pl. 1149. 1753.[7] (*Map 27*)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: SIERRA NEVADA—Mt. Dana, 13000 ft. (18166).

Intermontane Plateaus. BASIN AND RANGE PROVINCE: SPRING MOUNTAINS—Charleston Peak, 11910 ft. (17926, 17928, 18152).

Rocky Mountain System. MIDDLE ROCKY MOUNTAINS PROVINCE: WASATCH MOUNTAINS—Mt. Timpanogos, 12000 ft. (16682). SOUTHERN ROCKY MOUNTAINS PROVINCE: PARK RANGE—Wheeler Lake, 12300 ft. (S-2778). ELK MOUNTAINS—East Maroon Pass, 11850 ft. (10687); White Rock Mt., 13000 ft. (11006, 11014).

The specimens collected vary from one-lobed to many-lobed (var. COMPLICATUM) and from smooth below to intricately wrinkled below (var. PAPILLOSUM). The epithet *papillosum* is misleading because a truly papillose *Dermatocarpon* (*D. reticulatum*) occurs throughout western United States and Canada. Collection no. 18152 combines the characters of var. *complicatum* and var. *papillosum*.

2. DERMATOCARPON INTESTINIFORME (Körb.) Hasse, Bryol. 15: 46. 1912. *Endocarpon intestiniforme* Körb. Parerg. Lich. 42. 1859. (*Map 26*)

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Goat Mt., 8800 ft. (6493); Scenic Point, 7600 ft. (8854); Garden Wall, 8000 ft. (8435, 8455, 8465, 8496); Mt. Henkel, 6800 ft. (5586, 5588, 5597); Appekunny Mt., 8500 ft. (6254).

This is, according to Lamb (1948), a bipolar species found in

[7] Complete bibliographic citations are given for all taxa because of the many errors in current usage. Even recent monographs have neglected to conform to the International Code of Botanical Nomenclature. All citations have, therefore, been checked in the original reference unless otherwise noted, and the nomenclature is in accord with the International Code.

the Arctic, Iceland, Scandinavia, alpine areas of central Europe and Antarctica (East Graham Land). Lynge (1938) noted that it was more northern than *D. miniatum* and, in fact, doubted if *D. miniatum* occurred in the arctic. Lamb (1939), however, has reported *D. miniatum* var. *panniforme* from high altitudes in east Greenland.

Dermatocarpon intestiniforme is occasionally rather difficult to separate from the complicated or congested forms of *D. miniatum*. Both species are pruinose above. The growth form of *D. intestiniforme* is one of the best characters; *i.e.*, the edges of the lobes are rolled downwards, and the central portion of the thallus appears convex-areolate. The lower surface in *D. intestiniforme* is occasionally pruinose. Several authors rely on the shape and sizes of the spores, but as shown by Lamb (1939, 1948) and Dahl (1950) these are rather variable. The spores in *D. miniatum* are, however, usually somewhat longer (8-20 μ) and with a length/breadth-coefficient of approximately 2.0. The spores in *D. intestiniforme* are somewhat smaller (9-12 μ) and with an average coefficient of 1.5 (but occasionally up to 1.8).

Dematocarpon intestiniforme is frequently cited in the literature as *D. polyphyllum*, but the latter name is based on *Lichen polyphyllus* Wulf. (1788, p. 142) which refers to *Lichen polyphyllus* L. (= *Umbilicaria*).

3. DERMATOCARPON RETICULATUM H. Magn. Ann. Crypt. Exot. 5: 18. 1932. (*Map 28*)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17581).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Silvertip Mt., 2850 m. (*Lamb* 6437). SOUTHERN ROCKY MOUNTAINS PROVINCE: ELK MOUNTAINS—Virginia Ridge, 9600-12000 ft. (S-6221).

This species is distinguished from *D. miniatum* by the papillose undersurface. Its distribution appears to be limited to western United States and Canada. At first I believed this to be identical with *D. miniatum* var. *papillosum*, but examination of var. *papillosum* in European exsiccati (Anzi Lang. 266, Krypt. Vind. 158, Arn. 1750, Schaer. 646) showed that it was distinct, and the "papillose" undersurface of var. *papillosum* is in reality a condition of extreme rugosity. The papillose American material was first described by Fink as *D. moulinsii* var. *subpapillosum*. Magnusson, however, was the first to recognize it as a species under the name *D. reticulatum*. I cannot attach much significance to the occurrence of veins or reticulations in the *miniatum*-group of North

America and so I interpret *D. reticulatum* as including both smooth and reticulate forms, analogous to American material of *D. miniatum*. *Dermatocarpon vagans* Imsh. is a terricolous, drifting species, very closely related to *D. reticulatum*.

The alpine material cited above varies from monophyllous to complicated, and the lower surface varies from pale brown to black and almost smooth to reticulated. Lamb's no. 6437 was collected on rocks in a snowmelt rivulet, perpetually wetted.

STICTACEAE

LOBARIA

1. LOBARIA LINITA (Ach.) Rabenh. Deutschl. Krypt. Fl. 2: 65. 1845. *Sticta linita* Ach. Syn. Lich. 234. 1814. (*Map* 31)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17474).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Redoubt Mt., 2750 m. (*Lamb* 6315).

COLLEMACEAE (see Part II)

HEPPIACEAE (see Part II)

PANNARIACEAE (see Part II)

PELTIGERACEAE

SOLORINA

I am indebted to Dr. Weber and Dr. Shushan for their help with this genus. Their skill in the field has greatly increased our knowledge of the distribution of these species. In general, the genus is more common in the moister habitats at the lower limits of the alpine area.

1. Thallus pale gray or brown below 2
1. Thallus saffron-yellow or reddish-orange below ..... *S. crocea*
2. Spores 8 per ascus ..... *S. octospora*
2. Spores 2 or 4 per ascus 3
3. Spores 2 per ascus ..... *S. bispora*
3. Spores 4 per ascus ..... *S. saccata*

1. SOLORINA BISPORA Nyl. Syn. Lich. 1: 331, *pl.* 8, *f.* 42. 1860. (*Map* 63)

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—near Victoria Glacier (6918); Mt. Rundle, 8300 ft. (6000). LEWIS RANGE—Swiftcurrent Mt., 8300 ft. (7841, 7883); Siyeh Pass, 8200 ft. (9010). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 11500-12700 ft. (S-1591, S-3751). PARK RANGE—Hoosier Ridge, 13000 ft. (18956, 18993, 18994, 18995). SAWATCH RANGE—Lake Pass, 12225 ft. (11768). ELK MOUNTAINS—Conundrum Pass, 12700 ft. (S-5821); Virginia Basin to Virginia Ridge, 9600-12000 ft. (S-6229). SANGRE DE CRISTO RANGE—Trinchera Peak, 13500 ft. (12208).

Solorina bispora has been reported from White House Mt., 13000 ft., Ouray County, Colorado by Willey (1874). This evidently formed the basis of the record in Tuckerman (1882).

Lynge & Scholander (1932) mention that arctic material of *S. bispora* and *S. octospora* cannot be distinguished macroscopically. This does not seem to be true in western United States because *S. bispora* can usually be recognized by its small, pruinose thallus lobes with the apothecia sunken in deep wells. Occasionally there is merely a narrow annulus around the apothecia. *Solorina octospora* has larger, usually epruinose lobes, and the apothecia are more or less level with the thallus. A definite determination, however, must be based on the number of spores per ascus.

Solorina saccata (L.) Ach. Kgl. Vet. Acad. Nya Handl. 29: 228. 1808. *Lichen saccatus* L. Fl. Suec. ed. 2. 419. 1755. I have not seen any alpine collections of this species but it has been reported from an elevation of 7000 ft. on Mt. Baker in Washington by Herre (1943). The specimen which is in the Chicago Natural History Museum is, however, *Psoroma hypnorum*. This collection is also the basis for the report of *Solorina saccata* by Howard (1950).

2. Solorina octospora (Arn.) Arn. Verh. zool.-bot. Ges. Wien 26: 371. 1876. *Solorina saccata* var. *octospora* (*vel nova subspecies?*) Arn. Verh. zool-bot. Ges. Wien 23: 103. 1873. (*Map* 65)

Rocky Mountain System. Northern Rocky Mountains Province: Lewis Range—Wynn Mt., 7600 ft. (S-3146). Southern Rocky Mountains Province: Front Range—Mt. Evans, 11500-12600 ft. (S-1593, S-1593a, S-2920). Park Range—Hoosier Ridge, 13000 ft. (18992); Loveland Pass, 12500 ft. (S-2697). Elk Mountains—North Italian Peak, 11000-13300 ft. (S-6234).

See under *S. bispora* for a discussion of the macroscopic differences between the two species.

3. Solorina crocea (L.) Ach. K. Vet. Acad. Nya Handl. 29: 228. 1808. *Lichen croceus* L. Sp. Pl. 1149. 1753. (*Map* 64)

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17494); Moose Lake Trail, 6200-6500 ft. (17591). Cascade-Sierra Mountains Province: Northern Cascade Mountains—Windy Peak, 8345 ft. (18650); Tiffany Mt., 8275 ft. (18748); Slate Peak, 7488 ft. (18595); Pugh Mt., 7150 ft. (18476). Middle Cascade Mountains—Burroughs Mt., 6500-7400 ft. (197, 171, 17357).

Rocky Mountain System. Northern Rocky Mountains Province: Lewis Range—Swiftcurrent Pass, 7000 ft. (6134); Reynolds Mt., 7700 ft. (7774); Piegan Pass, 8000 ft. (7993, 8041). Southern Rocky Mountains Province: Front Range—Longs Peak, 12700 ft. (S-1507); above Fool Creek, 11500 ft. (S-1682); Mt. Evans, 12500-12900 ft. (11127, 11142, S-268, S-268a); Pikes Peak, 13000 ft. (11995). Park Range—Wheeler Lake,

12300 ft. (S-2726); Gray's Peak, 13700 ft. (S-46); Loveland Pass, 12500 ft. (S-2700). SAWATCH RANGE—Cottonwood Pass, 12250 ft. (11672).

This species has been reported from alpine areas on Mt. Baker, Washington by Herre (1917) and in Colorado by Tuckerman (1866b). Bouly de Lesdain's record (1932) from Lake Peak, New Mexico is not definitely stated to be alpine.

NEPHROMA

This genus has not been found in the alpine areas under consideration. *Nephroma arcticum* (L.) Torss. and *N. expallidum* (Nyl.) Nyl. are, however, found at lower elevations in the forested region of the Bow Range near Banff, Alberta.

PELTIGERA

The treatment of this genus follows the recent revision by Thomson (1950).

1. Algae of the thallus Chlorophyta; thallus bright green when moist; warty cephalodia containing *Nostoc* on the upper or lower surface of the thallus. (Section Phlebia) 2
1. Algae of the thallus Cyanophyta; thallus not bright green when moist; warty cephalodia absent. (Section Peltigera) 3
   2. Upper surface of the thallus with warty cephalodia and often marginally erect-tomentose; undersurface with scattered fasciculate rhizinae; thallus and lobes large, up to 6 cm. across; apothecia vertical ..... *P. aphthosa*
   2. Upper surface of the thallus lacking cephalodia and etomentose; undersurface with small black cephalodia on the veins; thallus small, up to 2 cm. across, attached centrally or at one side by a group of rhizinae; apothecia horizontal ..... *P. venosa*
3. Tomentum at margins erect; thallus without veins on lower surface ..... *P. malacea*
3. Thallus ± appressed to upper surface; thallus with veins on lower surface 4
   4. Upper surface with scattered peltate isidia ..... *P. lepidophora*
   4. Upper surface lacking peltate isidia (*P. canina*) 5
5. Upper surface without sorediate patches ..... *P. canina* var. *rufescens*
5. Upper surface with small sorediate patches ..... *P. canina* var. *spuria* f. *sorediata*

Section Phlebia Wallr.

1. PELTIGERA APHTHOSA[8] (L.) Willd. Fl. Berol. 347. 1787. *Lichen aphtosus* L. Sp. Pl. 1148. 1753. (*Map* 48)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17590). CASCADE-SIERRA MOUN-

[8] The specific epithet refers to the disease "thrush" and has its origin in the Greek word ἄφθαι. According to the Doctrine of Signatures the thallus which is dotted with small wart-like cephalodia was recommended for children who suffered from the "thrush" eruption. The original spelling of Linnaeus and Willdenow has been corrected, therefore, to *aphthosa*.

TAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7000 ft. (17422).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Swiftcurrent Pass, 7000 ft. (6233); Reynolds Mt., 7700 ft. (7776). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Longs Peak, 12000 ft. (S-4338); Mt. Evans, 12700 ft. (S-5618). SAWATCH RANGE—Lake Pass, 12225 ft. (11763).

Peltigera aphthosa has been reported from alpine areas in Colorado by Tuckerman (1866b, 1882) and from Mt. Baker, Washington by Herre (1917). It has been reported under the name of *P. variolosa* from Longs Peak, Colorado, by Kiener (1939) and from Lake Peak (without elevation), New Mexico, by Bouly de Lesdain (1932).

This species in alpine areas sometimes bears a superficial resemblance to *P. canina* var. *rufescens, i.e.*, the thallus is crisp with ± erect or ascending margins. This variation has been referred to in the literature as var. *complicata* Th. Fr. (Kiener, 1939) or f. *crispa* (Vain.) Zahlbr. (Thomson, 1950).

2. PELTIGERA VENOSA (L.) Baumg. Fl. Lipsiens. 561. 1790. *Lichen venosus* L. Sp. Pl. 1148. 1753. (*Map* 52)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7000 ft. (17418).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Swiftcurrent Pass, 7000 ft. (6163); Garden Wall above Grinnell Glacier, 8000 ft. (8454). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12000 ft. (S-2896).

Bouly de Lesdain (1942) has reported this species from an elevation of 3600 m. on Lake Peak, New Mexico.

Section Peltigera [= Emprostea (Ach.) Wain.]

Peltigera pulverulenta (Tayl.) Kremph. Flora 59: 62. 1876. *Peltidea pulverulenta* Tayl. Lond. Jour. Bot. 6: 184. 1847. This species has usually been referred to in the literature as *P. scabrosa* Th. Fr. and has been recorded from North America as arctic and arctic-alpine with stations from the Olympic Mountains, Montana and Colorado (Thomson, 1950, 1955; Craft, 1952a, b). The Colorado specimens are actually *Physicia grisea* according to Weber (personal communication). Craft (1952a) referred to a collection from Boulder Peak, Montana. This undoubtedly should read Boulder Peak, Washington.[9]

The combination *Peltigera pulverulenta* is usually credited to Nylander. Krempelhuber, however, was the first to write *Peltigera pulverulenta* since Nylander used *pulverulenta* as a subspecies of *Peltigera rufescens*.

See *P. canina* var. *rufescens* for a discussion of alpine material from Colorado annotated by Dahl as *P. scabrosa* var. *occidentalis* Dahl.

3. PELTIGERA MALACEA (Ach.) Funck, Crypt. Gewächse 33: 5. 1827. *Peltidea malacea* Ach. Syn. Lich. 240. 1814. (*Map* 51)

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE:

[9] See Thomson (1950, p. 23).

FRONT RANGE—Mt. Evans, 12500-12800 ft. (S-1602, S-275). PARK RANGE—Hoosier Ridge, 13000 ft. (19012).

Kiener (1939) has reported *P. malacea* from Longs Peak, Colorado.

4. PELTIGERA LEPIDOPHORA (Wain.) Bitter, Ber. deutsch. bot. Ges. 22: 251. 1904. *Peltigera canina* var. *lepidophora* Nyl. *ex* Wain. Meddel. Soc. Faun. Fl. Fenn. 2: 49. 1878. (*Map* 50)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18600). MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17423).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Piegan Pass, 8000 ft. (8053, 8075, 8080); Garden Wall above Grinnell Glacier, 8000 ft. (8423). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12600 ft. (S-2922). SAWATCH MOUNTAINS—Mt. Massive, 14418 ft. (11853). ELK MOUNTAINS—Virginia Basin, 12000 ft. (10609a).

This species has been reported from Longs Peak, Colorado, by Kiener (1939) and Thomson (1950).

The combination *Peltigera lepidophora* is usually credited to Wainio, but he actually used the taxon only as a subspecies.

5. PELTIGERA CANINA (L.) Willd. Fl. Berol. Prodrom. 347. 1787. *Lichen caninus* L. Sp. Pl. 1149. 1753. *Map* 49.

This species has been reported from Longs Peak, Colorado by Kiener (1939) and from New Mexico by Bouly de Lesdain (1932). All collections I have examined, however, can be referred to one of the following varieties.

Var. RUFESCENS (Weiss) Mudd, Man. Brit. Lich. 82. 1861. *Lichen caninus* var. *rufescens* Weiss, Pl. Crypt. Fl. Gottingens. 79. 1770.

Pacific Mountain System. PACIFIC BORDER PROVINCE. OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17522). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Tiffany Mt., 8275 ft. (18715); Slate Peak, 7488 ft. (18566); Pugh Mt., 7150 ft. (18480). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7400 ft. (191, 194, 196, 17409). SIERRA NEVADA—Piute Pass, 12000 ft. (18040).

Intermontane Plateaus. COLUMBIA PLATEAUS PROVINCE: WALLOWA MOUNTAINS—Eagle Cap, 9675 ft. (18831). BASIN AND RANGE PROVINCE: SNAKE RANGE—Wheeler Peak, 13061 ft. (17302). COLORADO PLATEAUS PROVINCE: LA SAL MOUNTAINS—Mt. Mellenthin, 12890 ft. (16875). SAN FRANCISCO MOUNTAINS—Agassiz Peak, 12340 ft. (17909).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Citadel Peak, 2730 m. (*Lamb* 6549). LEWIS RANGE—Swiftcurrent Pass, 7000 ft. (6200, 6213); Appekunny Mt., 8500 ft. (6274) Swiftcurrent Mt., 8300 ft. (7904); Piegan Pass, 8000 ft. (8044); Garden Wall above Grinnell Glacier, 8000 ft. (8491); Dawson Pass, 7500-8000 ft. (8638); Siyeh Pass, 8200 ft. (8983); Altyn Peak, 7500 ft. (5662). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18779). LOST RIVER RANGE—Pass Lake, 10000 ft. (16593). PIONEER MOUNTAINS—Hyndman Pass, 10600-11100 ft. (16643). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass,

11000 ft. (9668). Teton Range—Summit Divide, 10600 ft. (9137, 9160); pinnacle above Surprise Lake, 9900 ft. (9274). Wind River Range—Mt. Lester, 11700 ft. (19104). Big Horn Mountains—Loaf Mt., 11000 ft. (19129). Uinta Mountains—Leidy Peak, 12013 ft. (17203); Murdock Mt., 11000 ft. (16716). Wasatch Mountains—Mt. Baldy, 11049 ft. (16809); Mt. Timpanogos, 10850 ft. (16659). Southern Rocky Mountains Province: Medicine Bow Mountains—Medicine Bow Peak, 12000 ft. (18909). Front Range—Mt. Evans, 12500-12900 ft. (S-906, S-1600, S-1607, 11128); Upper Green Lakes north of Kiowa Peak, 11500 ft. (S-1444). Park Range—Hoosier Ridge, 13000 ft. (19010); Wheeler Lake, 12300 ft. (S-2777). Sawatch Mountains—Mt. Massive, 12750-14418 ft. (11870, 11890). Elk Mountains—Gothic Mt., 12600 ft. (10387); Virginia Basin, 12000 ft. (10648). San Juan Mountains—Blue Lake Pass, 12500 ft. (16937, 17014, 17015). San Miguel Mountains—Black Face, 12200 ft. (17186). Sangre de Cristo Range—Gold Hill, 12660 ft. (12403).

Peltigera canina var. *rufescens* has been reported from Longs Peak, Colorado, by Kiener (1939), from Pikes Peak, Colorado, by Thomson (1950), and from the summit of Mt. Olympus, Olympic Mountains, Washington, by Thomson (1950).

In alpine areas this variety is usually "complicated" with crisp, erect margins. Gyelnik referred to this condition as f. *incusa* Flot. This variety has been collected with small pink mounds scattered on the upper surface. These areas represent the fungus *Illosporium carneum* Fr., and the resulting parasitized lichen might be mistaken for *P. canina* var. *spuria* f. *sorediata*.

A number of Colorado specimens (S-1600, S-1607, S-2777) are dark brown and rather leathery in texture. In places they are almost scabrose but they still retain a distinct tomentum at the very tips of the laciniae. These specimens have been annotated by Dahl as *P. scabrosa* var. *occidentalis* Dahl. I believe that these collections represent merely a minor variation of *P. canina* var. *rufescens*.

Var. spuria f. sorediata Schaer. Enum. Crit. Lich. Europ. 21. 1850.

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17485). Cascade-Sierra Mountains Province: Middle Cascade Mountains—Burroughs Mt., 6500-7300 ft. (195). Sierra Nevada—Mt. Dana, 13000 ft. (18155).

Rocky Mountain System. Middle Rocky Mountains Province: Big Horn Mountains—Loaf Mt., 11000 ft. (19177). Southern Rocky Mountains Province: Front Range—Mt. Evans, 12700-14260 ft. (S-5620, 11055); Pikes Peak, 14100 ft. (S-5684). Park Range—Hoosier Ridge, 13000 ft. (18981). Sawatch Mountains—Mt. Massive, 14418 ft. (11853). San Juan Mountains—Blue Lake Pass, 12500 ft. (17010, 17011).

Kiener (1939, sub *P. crumpens*) has reported this form from Longs Peak, Colorado.

The thallus of *Peltigera* species may occasionally be parasitized by the fungus *Illosporium carneum* Fr., and the small pink mounds of the fungus might be mistaken for soralia. Collection no. 5662 of *P. canina* var. *rufescens* is an example of this condition.

Stereocaulaceae

Stereocaulon

All the specimens of this genus were studied by Dr. I. Mackenzie Lamb, and the following treatment of *Stereocaulon* is based entirely on his determinations and comments. I am very grateful to him for this help in a genus which is very difficult in the alpine areas since many collections are small and depauperate. This may be due in part to their growing under severe conditions.

1. Pseudopodetia minute (2-4 mm. long), chalky-white bearing torulose lumps but no definite phyllocladia ..... *S. subalbicans*
1. Pseudopodetia larger, not chalky-white, bearing well-defined phyllocladia 2
   2. Pseudopodetia hard, woody, naked, often longitudinally striate or cracked; plants usually firmly attached to rock by basal holdfasts 3
   2. Pseudopodetia not woody, not striated or cracked, ± tomentose; plants not very firmly attached to substratum, without basal holdfasts 4
3. Phyllocladia concentrated towards apices of pseudopodetia, habitus therefore distinctly cauliflower-like; pseudopodetia ± erect, forming hemispherical tufts ..... *S. botryosum*
3. Phyllocladia laterally distributed on pseudopodetia, habitus not distinctly cauliflower-like; pseudopodetia often decumbent, forming small flattened mats or cushions ..... *S. depreaultii* var. *caespitosulum*
   4. Primary thallus ± persistent; tomentum compact, smooth, felted; cephalodia large, conspicuous, smoothly rounded, brown, sometimes fissured (*S. glareosum*) 5
   4. Primary thallus soon evanescent; tomentum looser, spongy to floccose; cephalodia smaller, inconspicuous, of different type from above 6
5. Phyllocladia distinctly elongated (digitate) ... *S. glareosum* var. *glareosum*
5. Phyllocladia grain-like or verrucose, not elongated ..... *S. glareosum* var. *brachyphylloides*
   6. Phyllocladia small, grain-like, often formed from the apices of the terminal pseudopodetial branches (phyllocladioid branchlets); cephalodia minute, brownish, slightly botryose; plants fragile ..... *S. rivulorum*
   6. Phyllocladia larger, verrucose-squamuliform to squamuliform, lateral on pseudopodetia (not formed from branch-apices); cephalodia small, whitish, greenish or aeruginose, amorphous to ± botryose; plants not noticeably fragile 7
7. Tomentum heavy, loosely floccose; phyllocladia (at least in lower parts of pseudopodetia) flattened, incised-squamuliform; apothecia usually abundant, small, lateral ..... *S. tomentosum*

7. Tomentum thinner, more adpressed; phyllocladia flattened-verruciform; apothecia somewhat rare, apical or subapical.....*S. alpinum*

Subgenus Stereocaulon (= Enteropodium M. Lamb)
Section Chondrocaulon Th. Fr.

1. **Stereocaulon subalbicans** M. Lamb, sp. nov. (*fig.* 1; *map* 70).

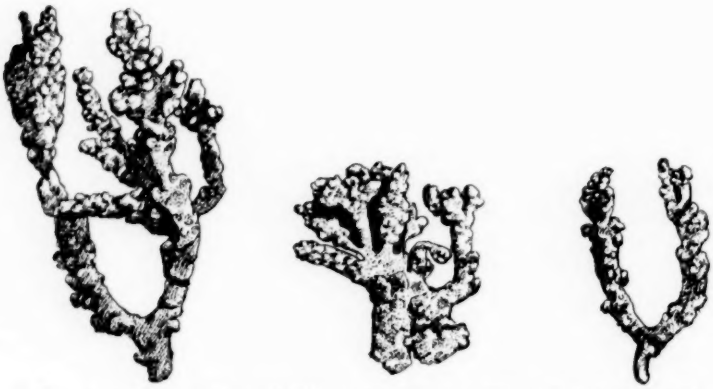


FIG. 1. *Stereocaulon subalbicans* M. Lamb. Three detached pseudopodetia from the type-material (*Santesson* 2530), × 7.

Pseudopodetia congesta, pusilla, longit. 2-3(4) mm., crassit. 0.25-0.50 mm., erecta vel subdecumbentia, inferne in terram defossa; irregulariter ramosa, teretia aut passim leviter complanata, alba vel albida, opaca, superficie mollescenti, phyllocladiis veris haud praedita, sed invicem glebulis indistinctis concoloribus 0.1-0.2 mm. diam. obtecta; ecorticata, in toto e hyphis varie contextis et granulose nubilatis formata (axe centrali chondroideo nullo), algas symbioticas valde irregulariter sparsas foventia. [Cephalodia, apothecia et pycnidia desunt.]—React. (in typo); pseudopodetia KHO—, PD+ intense persistenterque flavescens, C—; atranorinum, acidum psoromicum et acidum divaricaticum continens.—Species ut videtur *St. albicanti* Th. Fr. affinis et antea cum ea saepe commixta, habitu autem magis irregulari et defectu phyllocladiorum insignium bene dignota.—Holotypus e Chile, Prov. Coquimbo, La Serena, Cerro Los Loros, anno 1940 a cel. R. Santesson (no. 2530) ad terram nudam lectum, in Farlow Herb. Univ. Harvard asservatur; isotypus in Herb. Mus. Hist. Nat. Stockholmensis adest.

The type material was growing on bare earth on a dry hillside, and forms continuous crusts 3 cm. or more in diameter. The bases

of the pseudopodetia penetrate for some millimeters into the earth and appear to die off gradually below. Emergent portions 2-3(4) mm. high, 0.25-0.50 mm. thick, upright or ± decumbent, crowded, irregularly branched, terete or slightly irregularly flattened, white or cinereous whitish (without any yellowish tinge), mat, of soft appearance, more or less uniformly covered with concolorous, ill-defined, irregular, small lumps 0.1-0.2 mm. diam. No cephalodia, apothecia or pycnidia. Pseudopodetia KHO—, PD+ (quickly) intense persistent yellow, C—.

Sections in water ± opaque and densely nubilated with yellowish-gray granules (insoluble in KHO, dissolving in PD with effusion of yellow solution); ecorticate, of undifferentiated structure, with the symbiotic algae mostly in clumps near the surface, chiefly in the small lumps, but present also deeply imbedded inside the pseudopodetia, and without regularity in their distribution. Algae bright green (Chlorococcales), globose, 6-10 μ diam., thin-walled. The outer clumps of algae are covered by a layer 7-15 μ deep of loosely interwoven hyphae similar to those forming the rest of the pseudopodetium, and often loose and discrete, as in tomentum. No central axis differentiated; the whole pseudopodetium is of homogeneous structure, consisting of compactly interwoven hyphae running in various directions. Hyphae 3-4 μ thick, fairly thin-walled, branched septate.

The species resembles *St. albicans* Th. Fr. *emend.* M. Lamb and has often been confused with the latter but is distinct not only in the absence of well-defined grain-like phyllocladia, but also in the anatomical structure, without distinction between central axis and outer cylinder.

Several distinct chemical strains of this species exist. The type (Ch. str. I) contains, in addition to atranorine, psoromic and divaricatic acids; part of the material was kindly analyzed by Dr. Y. Asahina in 1949. Chemical strain II contains thamnolic acid and an unidentified fatty acid, with or without the addition of atranorine; specimens of this strain were collected in Montana (*Imshaug* 6366, 7979, 18762, 18769), Washington (*Imshaug* 18497, 18700) and Colorado (*Weber* & *Shushan* S-2721). Analyses of these were kindly made by Dr. Mason Hale in 1956 and 1957. Chemical strain II also has been collected in South America, Juan Fernandez (*C.* and *I. Skottsberg*, 1917). Other strains seen to date are Ch. str. III (lecanoric acid), a specimen from Chile (*Sparre*, 1947); and Ch. str. IV (atranorine only, probably better to be regarded as a deficient phase of one of the other strains), a specimen from Peru (*Vargas*, 1949).

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18700); Pugh Mt 7150 ft. (18497).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Mt. St. Piran, 2895 m. (*Lamb* 6307); Silvertip Mt., 2860 m. (*Lamb* 6351). LEWIS RANGE—Piegan Pass, 8000 ft. (7979, 7990, 8052). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18762, 18769). SOUTHERN ROCKY MOUNTAINS PROVINCE: PARK RANGE—Wheeler Lake, 12300 ft. (S-2721).

Section Stereocaulon (= Eustereocaulon Körb.)

2. STEREOCAULON ALPINUM Funck,[10] Crypt. Gewächse 33: 6. 1827. (*Map* 66)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Pugh Mt., 7150 ft. (18482); Slate Peak, 7488 ft. (18578). MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17467).

ROCKY MOUNTAIN SYSTEM. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Piegan Pass, 8000 ft. (8074); Siyeh Pass, 8200 ft. (8998); Logan Pass, 7700 ft. (S-3145). MIDDLE ROCKY MOUNTAINS PROVINCE: WIND RIVER RANGE—Mt. Lester, 11700 ft. (19061). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12700-13100 ft. (11104, 11124, S-501, S-278); Longs Peak, 13700 ft. (S-10877, probably, but too fragmentary). PARK RANGE—Grays Peak, 13700 ft. (S-1924); Wheeler Lake, 12500 ft. (S-2776). SAWATCH MOUNTAINS—Lake Pass, 12225 ft. (11777). SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16966).

Stereocaulon alpinum has been reported from the Cascade Mountains of Washington by Howard (1937, 1950) and from the summit of Mt. Hood in Oregon by Tuckerman (1882).

Other collections may represent this species but only unquestionable determinations are cited above. Specimens from the northwest are difficult to determine with certainty and a number of collections from the Olympic Mountains (17499, 17504, 17601) and the northern Cascade Mountains (18472) may be either *S. alpinum* or *S. tomentosum*. *Stereocaulon rivulorum* may also be difficult to separate from *S. alpinum* and a specimen from Mt. Rainier National Park in Washington (17407) and one from Pikes Peak in Colorado (11966) could be either *S. rivulorum* or *S. alpinum*.

A collection from the Big Horn Mountains, Wyoming is possibly *S. alpinum* but it is too fragmentary for certain determination.

3. STEREOCAULON BOTRYOSUM Ach. Lich. Univ. 581. 1810. (*Map* 67)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Ridge between North and Middle Sisters, 9000 ft. (18363).

[10] Laurer's name appears on the exsiccatae specimens (no. 684) but not in the publication.

The above cited collection can be referred to f. DISSOLUTUM (H. Magn.) Frey. It represents Chemical strain I of the species, containing only atranorine. A collection (17587) from the Olympic Mountains of Washington may also represent *S. botryosum* but it is very stunted and is aberrant in that it contains lobaric acid in addition to atranorine.

4. STEREOCAULON DEPREAULTII Del. *ex* Nyl. Syn. Lich. 1: 249. 1860. var. **caespitosulum** (Nyl.) Lamb, comb. nov.[11] *Stereocaulon denudatum* var. *caespitosulum* Nyl. Syn. Lich. 1: 247. 1860. (*Map* 68)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Pugh Mt., 7150 ft. (18475).

This variety is common in the New England mountains, New York State and eastern Canada. The previous westernmost station known, however, was in Minnesota on the north shore of Lake Superior. This report represents, therefore, a considerable western extension of its range. Dr. Lamb also states that this collection is exactly similar to those which occur in the White Mountains of New England.

5. STEREOCAULON GLAREOSUM (Sav.) H. Magn. Göteborgs K. Vet.-och Vitterh.-Samh. Handl. IV. 30(7): 60. 1926. *Stereocaulon tomentosum* f. *glareosum* Sav. Bull. Jard. Imp. Bot. Pierre le Grand 14: 121. 1914. (*Map* 69)

In addition to the specimens cited below there are collections which can only be referred to *S. glareosum* with some question. These uncertain determinations come from the Middle Cascade Mountains (186), Sierra Nevada (18057, 18134, 18242), Northern Rocky Mountains (5702) and Southern Rocky Mountains (S-10874, 10719).

Var. GLAREOSUM.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—ridge between North and Middle Sisters, 9000 ft. (18382, 18363).

Rocky Mountain System. MIDDLE ROCKY MOUNTAINS PROVINCE: BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19122). SOUTHERN ROCKY MOUNTAINS PROVINCE: SAWATCH MOUNTAINS—Mt. Massive, 14418 ft. (11880).

Var. BRACHYPHYLLOIDES M. Lamb *in* Llano, Jour. Wash. Acad. Sci. 41(6): 196. 1951.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18651); Tiffany

[11] The combination was published by Lamb *in* Thomson, THE BRYOLOGIST 57: 284. 1954. The required basionym citation, however, was not given at that time, and so the combination is officially made at this time to conform with the International Code of Botanical Nomenclature.

Mt., 8275 ft. (18731, with ?). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7300 ft. (188).

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: PARK RANGE—Wheeler Lake, 12300 ft. (S-2776). SAWATCH MOUNTAINS—Mt. Massive, 14418 ft. (11855). SAN MIGUEL MOUNTAINS—Black Face, 12200 ft. (17139). SANGRE DE CRISTO RANGE—West Spanish Peak, 13623 ft. (12042, 12060).

In addition to the above specimens a collection from Glacier National Park in Montana could be either *S. glareosum* var. *brachyphylloides* or *S. rivulorum*.

6. STEREOCAULON RIVULORUM H. Magn. Göteborgs K. Vet.- och Vitterh.-Samh. Handl. IV. 30(7): 63. 1926. (*Map* 71)

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12800-13100 ft. (S-1601).

A number of other collections might represent this species although they cannot be determined with certainty. These questionable specimens come from the Middle Cascade Mountains (17407, might be *S. alpinum*), Northern Rocky Mountains (5705, 6270, 8858, 8879, 8034, all might be *S. glareosum* var. *brachyphylloides*) and Southern Rocky Mountains (11105, 11942, 11966, all might be *S. alpinum*, S-2767).

STEREOCAULON TOMENTOSUM Fr. Sched. Crit. 3: 20. 1824. Although no alpine material could be determined as unquestionably belonging to this species there were a few collections which could be either *S. alpinum* or *S. tomentosum*. These came from the Olympic Mountains (17499, 17504, 17601) and the Northern Cascade Mountains (18472). *Stereocaulon tomentosum* might, therefore, be looked for in the alpine areas of the northwest.

CLADONIACEAE

CLADONIA

The arrangement of species follows that of Mattick (1938, 1940), Frey (1952) and Evans (1952a). The key is patterned after Evans (1930) and Hale (1954). I prefer, however, to follow the more conservative treatment of the *coccifera* and *pyxidata* groups as in Dahl (1950) and Frey (1952).

1. Primary thallus squamulose or foliose, ± persistent 2
1. Primary thallus crustaceous, soon disappearing; podetia stramineous, repeatedly and intricately branched, forming complex branch-systems; not cup-forming and not squamulose; PD—; KOH— ..... *C. mitis*
2. Primary squamules and podetia stramineous; podetia (poorly developed in alpine areas) cup-forming; apothecia red (but rarely present in alpine areas) (*C. coccifera*) 3
2. Primary squamules and podetia glaucescent (not tinged with yellow) 4
3. Podetia esorediose, with scattered areoles ..... *C. coccifera* var. *coccifera*
3. Podetia with granular soredia ..... *C. coccifera* var. *pleurota*
4. Podetia acuminate and narrow, with no cups or very narrow cups at the tips; basal squamules frequently evanescent 5
4. Podetia cup-forming, stout; basal squamules well developed 8
5. Podetia sorediose, PD+ ..... *C. subulata*

5. Podetia esorediose, PD+ or— 6
6. Cortex subcontinuous or of dispersed areolae; podetia short, less than 1.5 cm. high; KOH+ yellow (atronorine present); PD— or weak orange (fumar-protocetraric acid absent); apothecia usually present ..... *C. cariosa*
6. Cortex continuous; PD+ red (fumar-protocetraric acid present); apothecia usually absent 7
7. KOH— (atronorine absent) ..... *C. gracilis*
7. KOH+ yellow (atronorine present); podetia coarser and cortex smoother ..... *C. ecmocyna*
8. Cups shallow, saucer-form; proliferations frequent from the margins of the cups ..... *C. gracilis*
8. Cups deep, goblet-form (*C. pyxidata*) 9
9. Primary squamules free, ascending; not sorediate ..... *C. pyxidata* var. *pyxidata*
9. Primary squamules ± adnate and appressed to the substratum; not sorediate ..... *C. pyxidata* var. *pocillum*
9. Podetia granular-sorediate ..... *C. pyxidata* var. *chlorophaea*

Subgenus Cladonia [= Eucladonia (Eschw.) Mattick]
Section Cladonia [= Clausae Körb.]
Subsect. Cocciferae Del.

1. CLADONIA COCCIFERA (L.) Willd. Fl. Berol. Prodr. 361. 1787. *Lichen cocciferus* L. Sp. Pl. 1151. 1753. (*Map* 15)

Var. COCCIFERA.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17515, 17563). CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7100-7400 ft. (17369); Mt. Fremont, 7100-7200 ft. (17457).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Piegan Pass, 8000 ft. (8073a). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9690). TETON RANGE—Summit Divide, Indian Paintbrush Trail, 10600 ft. (9191). BIGHORN MOUNTAINS—Loaf Mt., 11000 ft. (19149). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18898). FRONT RANGE—Mt. Evans, 13100 ft. (11114a, 11117). PARK RANGE—Hoosier Ridge, 13000 ft. (18972).

The podetia are usually very poorly developed in alpine areas, but the color of the primary squamules is distinctive. The red apothecia were never found above timberline. The above material is PD— and contains usnic acid plus barbatinic acid. Zeorine was apparently absent.

Var. PLEUROTA (Floerke) Schaer. Lich. Helv. Spic. 25. 1823. *Capitularia pleurota* Floerke, Ges. Naturf. Freund. Mag. 2: 218. 1808.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Pugh Mt., 7150 ft. (18465, 18468).

Subsect. Podostelides (Wallr.) Wain.

2. CLADONIA CARIOSA (Ach.) Spreng. *in* L. Syst. Veg. ed. 16. 4: 272. 1827. *Lichen cariosus* Ach. Lich. Suec. Prodr. 198. 1798. (*Map* 16)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17515a). CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17447).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE— Piegan Pass, 8000 ft. (7977).

This is a very common and characteristic species in the forested regions of the western mountain ranges but only occasionally is found above timberline.

Subsect. Thallostelides Wain.

3. CLADONIA GRACILIS (L.) Willd. Fl. Berol. Prodr. 363. 1787. *Lichen gracilis* L. Sp. Pl. 1152. 1753. (*Map* 18)

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12800 ft. (S-1603).

The above collection is rather depauperate, but an analysis for the presence of atronorine was negative.

Var. CHORDALIS (Flk.) Schaer. Lich. Helv. Spic. 32. 1823. *Capitularia gracilis* var. *chordalis* Flk. Weber & Mohr's Beiträge 2: 324. 1810.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17451).

Atronorine is absent from the above collection. This variety has also been reported from the Cascade Mountains of Washington by Howard (1950) and from Lake Peak, New Mexico (without elevation) by Bouly de Lesdain (1932).

4. CLADONIA ECMOCYNA (Ach.) Nyl. Notis. Sällsk. Faun. Fl. Fenn. Förh. 8: 176. 1866. *Cenomyce ecmocyna* Ach. Lich. Univ. 549. 1810. (*Map* 17)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17589, 17596, 17609). CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17469); Burroughs Mt., 6500-7400 ft. (193, 17364).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Reynolds Mt., 7700 ft. (7765).

Cladonia ecmocyna var. *macrocera* has been reported from Colorado at elevations of 9000-11800 ft. by Evans (1952b). Evans also reports many collections from the Banff-Lake Louise area in the Canadian Rocky Mountains, collected by Lamb, but none of these are alpine. The material which

is the basis for the report of *C. amaurocraea* from the Cascade Mountains of Washington by Howard (1937) is actually *C. ecmocyna* as noted by Evans (1952b).

5. CLADONIA PYXIDATA (L.) Hoffm. Deutschl. Fl. 2: 121. 1796. *Lichen pyxidatus* L. Sp. Pl. 2: 1151. 1753. (*Map* 20)

Var. PYXIDATA.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17539, 17560). CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17456).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Mt. Rundle, 8300 ft. (6602). LEWIS RANGE—Goat Mt., 8800 ft. (6506). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18873). FRONT RANGE—Mt. Evans, 12700 ft. (S-1606). PARK RANGE—Hoosier Ridge, 13000 ft. (19019). ELK MOUNTAINS—Virginia Ridge, 12300-12400 ft. (10572). SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16942).

The collections cited above are PD+. No. S-1606 has been identified by Dr. Evans as f. SIMPLEX. This variety has been reported by Bouly de Lesdain (1932, 1942, sub. var. *neglecta*) from an elevation of 3600 m. on Lake Peak, New Mexico.

Var. POCILLUM (Ach.) Flot. Linnaea 17: 19. 1843. *Baeomyces pocillum* Ach. Meth. Lich. 336, *pl.* 8, *f.* 6. 1803.

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Garden Wall, 8000 ft. (8438); Siyeh Pass, 8200 ft. (8986). MIDDLE ROCKY MOUNTAINS PROVINCE: BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19161). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12700 ft. (S-1609, 11114). PARK RANGE—Hoosier Pass, 13000 ft. (18976). (Collection no. S-1609 was determined by Dr. Evans.)

Var. CHLOROPHAEA (Flk. *in* Sommerf.) Flk. Clad. Comm. 70. 1828. *Cenomyce chlorophaea* Flk. *in* Sommerf. Suppl. Fl. Lappon. 130. 1821.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17485a). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18655, 18678); Slate Peak, 7488 ft. (18596). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7100-7400 ft. (17344); ridge between North and Middle Sisters, 9000 ft. (18369).

Intermontane Plateaus. COLORADO PLATEAUS PROVINCE: LA SAL MOUNTAINS—Mt. Mellenthin, 12890 ft. (16888). SAN FRANCISCO MOUNTAINS—Agassiz Peak, 12340 ft. (17894).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Siyeh Pass, 8200 ft. (8999); Piegan Pass, 8000 ft. (8073). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9769). TETON RANGE—Pinnacle above Surprise Lake, 9900 ft. (9219). BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19172). UINTA

Mountains—Bald Mt., 11947 ft. (16724). Southern Rocky Mountains Province: Front Range—Above Fool Creek, 11500 ft. (S-1673); Mt. Evans, 12500-12900 ft. (S-272, 11139). Park Range—Hoosier Ridge, 13000 ft. (18963); Wheeler Lake, 12300 ft. (S-2771). Sawatch Mountains—Independence Pass, 12100 ft. (11545, 11578). Elk Mountains—Virginia Basin, 12000 ft. (10643). Sangre De Cristo Range—Gold Hill, 12660 ft. (12371).

The above material, except for no. 17485a, is PD+.

Cladonia subulata (L.) Wiggers, Prim. Fl. Holsat. 90. 1780. *Lichen subulatus* L. Sp. Pl. 1153. 1753. Pacific Mountain System. Cascade-Sierra Mountains Province: Middle Cascade Mountains—Ridge between North and Middle Sisters, 9000 ft. (18365). This is a rather depauperate collection which seems to fit best what has generally been called *C. cornutoradiata* f. *subulata*. Wainio's concept of *C. cornutoradiata*, however, included *Lichen subulatus* L. (1753), *Lichen radiatus* Schreb. (1771), and *Cladonia furcellata* Hoffm. (1796). All these names take precedence over *cornutoradiata* on the specific level! Most authors have followed Wainio's arrangement but Choisy (1951) has recently interpreted Linnaeus' *L. subulatus* as a member of the *C. furcata*-group and adopted the name *Cladonia radiata* for *C. cornutoradiata*. The removal of *L. subulatus* from the *C. fimbriata*-group is not in accordance with general custom, and it seems best to continue to follow Wainio's interpretation of the Linnaean species. The correct name for this species then is *C. subulata*.

Subsect. Unciales (Del.) Wain.

Cladonia amaurocraca (Flk.) Schaer. has been reported from the Cascade Mountains of Washington by Howard (1937). The specimen upon which this record was based is, however, *C. ecmocyna* according to Evans (1952b).

Subgenus Cladinae (Nyl.) Wain.

6. Cladonia mitis Sandst. Clad. Exsicc. 55. 1918. (*Map* 19)

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17484, 17528, 17552, 17556, 17560a). Cascade-Sierra Mountains Province: Northern Cascade Mountains—Slate Peak, 7488 ft. (18589).

Rocky Mountain System. Northern Rocky Mountains Province: Bow Range—Mt. St. Piran, 2850 m. (*Lamb* 6302); Citadel Peak, 2730 m. (*Lamb* 6592).

In addition to the specimens cited above there is a collection in the University of Colorado Herbarium (S-1445) from Upper Green Lakes Valley, north of Kiowa Peak, Boulder County, Colorado. It was found in rather depauperate colonies in boggy places around a small seepage pool at about 11500 ft. I am uncertain as to whether this is an alpine area, and so it is not included with the other specimens.

UMBILICARIACEAE

The description of a new and possibly primitive species in this family has necessitated an appraisal of the two classification schemes currently in use. Frey (1931) has recognized only one genus with subgenera based on spore characters and sections based on the morphology and anatomy of the thallus and apothecia. Scholander (1934), however, has proposed four genera based on gyrus development and within three of these genera there are two sections, one with non-septate spores and one with muriform spores.

The species groupings as recognized by Frey appear basically sound, as indicated by his analysis (Frey, 1936b, 1947, 1950) of their distributions. On the other hand, the work of Scholander is fundamental to an understanding of the phylogeny of the Umbilicariaceae, although the assumption that the development of one character can have inherent value above all others seems unwarranted. A comparison of these two schemes shows, however, that the differences are not as great as they might at first appear. Frey's section Anthracinae has been divided into the genera *Agyrophora*[12] and *Omphalodiscus*. Scholander's *Actinogyra* has simply been separated from Frey's section Velleae; a separation which Frey (1936a) endorses, at least in part. Scholander's *Umbilicaria*[12] is composed of Frey's sections Velleae, Glabrae and Polymorphae. An important difference here is Scholander's removal of the omphalodisk species to *Omphalodiscus*. Frey's subgenus Gyrophoropsis has been distributed by Scholander into the other genera as sections because of the lesser importance attached by Scholander to spore septation.

In evaluating these two systems it should be remembered that Frey has based his scheme on a careful and detailed study of related species. Scholander, on the other hand, has studied *only one line of development* along which he has recognized (1934, pp. 18-19) "four morphologically well characterizable stages" as "genus abstractions." Scholander (1934) has not made an attempt to recognize species relations within these genera, except for sections based on spore septation.

Before outlining my own ideas concerning the relationships within the Umbilicariaceae I believe it is necessary to outline the major lines of development which appear to me to have taken place within the family. These are as follows:

[12] The nomenclaturally correct names *Agyrophora* and *Umbilicaria* are used throughout this discussion for Scholander's *Umbilicaria* and *Gyrophora*, respectively. The reasons for this are given in Llano (1950).

(1) *Apothecial Type:* The majority of species have a superlecideoid type of apothecium as described by Frey (1936a) and Dughi (1952, 1954). The apothecia emerge through development of a thallus pedicel rather than an apothecial stipe as in the Lecideaceae (Galløe, 1950) and Physciaceae (Imshaug, 1957). This thalloid tissue has been called a pseudostroma by Choisy (1931). In this type of apothecial development the hyphae of the exciple revert partially to an assimilative role and are similar and comparable with the hyphae of the pseudostroma. This reversion is not as complete as it is in the lecanoroid type because the hyphae are not receptive to the development of algae. This type of apothecial margin is called an amphithecium (Frey, 1936a).

In one line of development the apothecia are round and more or less raised above the level of the thallus, or even stipitate. The amphithecium is well developed and becomes receptive to the growth of algae.

In another line of development the apothecia are adnate and very irregular, becoming elongate, angular, stellate or variously lobed. The amphithecium is very poorly developed and occasionally lacking.

(2) *Gyrus Formation:* The line of development suggested by Scholander (1934) appears fundamentally correct, but I believe that it has occurred more than once in the family; *i.e.*, the gyrodisk apothecia in sections Velleae and Polymorphae represent two different lines of development. Frey (1936a) also alluded to the probable polyphyletic origin of the gyrodisk apothecia as illustrated by the closely related species *virginis-cylindrica* and *torrefacta-phaca-angulata-polyrrhiza.*

(3) *Spore Septation:* It seems most probable, as stated by Scholander (1934) and Llano (1950), that spore septation has been initiated at various points in the family and only in Lasallia has it reached a point where it characterizes a well isolated taxon. The primitive spore is small, eight per ascus, hyaline and non-septate, while the most advanced spore is large, two per ascus, brown and muriform.

(4) *Umbilicate Thallus:* The centrally umbilicate thallus is probably the most advanced thallus type in the family. Galløe (1950) has already shown that not all species are really umbilicate and he has suggested (p. 32) that the thallus developed originally as an "unbranched small frond, unilaterally fixed at the base, next spreading out fan-like in all directions until at length it shuts up and becomes orbicular." Galløe also notes (p. 32) that "some individuals occasionally are split up at one side throughout to the hold-fast (umbilicus) while other specimens are polyphyllous, thus reminding of a *Parmelia.*" I believe, especially in view of the discovery of *U. lambii,* that the primitive condition is represented by a crustose, areolate thallus raised from the substratum by a mass of irregular lamellae and which marginally becomes indistinctly lobed or vaguely umbilicate. *Umbilicaria angulata* represents a somewhat less primitive condition.

The lines of development suggested above may be incorporated into a phylogenetic scheme as illustrated in figure 2. *Umbilicaria lambii* is considered the most primitive species and has the major primitive characters listed above. The line culminating the section Polymorphae has round apothecia with well-developed amphithecia, becoming almost lecanoroid. In the other lines the apothecia are irregular, or angular, frequently more or less stellate, with margins poorly developed or absent.

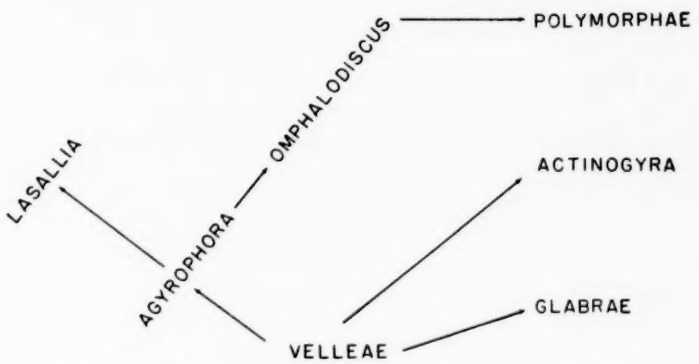


FIG. 2. Suggested relationships within the Umbilicariaceae. The generic names (*Lasallia, Agyrophora, Omphalodiscus* and *Actinogyra*) are used in the sense of Scholander and Llano while the section names (Velleae, Glabrae and Polymorphae) are used in the sense of Frey with slight modifications as described in the text.

If this scheme is accepted it seems best to recognize only one genus, as Frey has done. If, however, one prefers to recognize more than one genus, it is necessary to have two genera for species with gyrodisk apothecia. Also, *Agyrophora* would need to be redefined to exclude *U. lambii*. The best defined and most isolated group in figure 1 is Lasallia, and I believe it is best treated as a subgenus, as Frey has done. The remaining groups would therefore be included as sections in subgenus Umbilicaria. The species of Actinogyra, however, are so closely related to certain species in section Velleae that it seems best to consider Actinogyra as a subsection of section Velleae.

1. Rhizinae sparse to continuous on the lower surface 2
1. Rhizinae absent on the lower surface 6
2. Upper surface plane to broadly undulating; margins not perforate or fenestrate 3
2. Upper surface reticulate with black indented lines; margins perforate to fenestrate; lower surface radiately ridged with lamellae extending to margin, light brown ..... *U. torrefacta*
3. Rhizinae attenuate, marginal or projecting past the margins 4
3. Rhizinae dense with enlarged tips, interspersed with long cylindrical, paler rhizinae; lower surface dark brown to black; ± white pruinose above ..... *U. vellea*
4. Apothecial disks with gyri (gyrodisks) 5
4. Apothecial disks plane with central papillae or irregular fissures (omphalodisks); rhizinae not marginal but often projecting past the margin ..... *U. virginis*
5. Rhizinae marginal; lower surface light colored ..... *U. cylindrica*

5. Rhizinae not marginal, granulose, intricately branched, forming a tangled mat; upper surface dark brown with pustules; lower surface dark and granulose, without central umbilicus.....*U. angulata*
6. Upper surface with isidia.....*U. deusta*
6. Upper surface without isidia..... 7
7. Apothecia present..... 8
7. Apothecia absent (see also *Dermatocarpon* sect. Entosthelia)..... 11
8. Apothecial disks with gyri (gyrodisks)..... 9
8. Apothecial disks plane (leiodisks) or with central papillae and/or irregular fissures (omphalodisks)..... 10
9. Upper surface with well developed, appressed to broad vermiform rugi extending to margins; lower surface dark gray to brown or black; center of thallus not prominent.....*U. hyperborea*
9. Upper surface reticulate-rugose, rugi fading marginally, umbo pruinose; lower surface dark gray.....*U. proboscidea*
10. Apothecia of omphalodisk type.....*U. kraschenninkovii*
10. Apothecia of leiodisk type.....*U. coriacea*
11. Thallus margins perforate or fenestrate; upper surface recticulate-rugose with rugi fading marginally, occasionally with erect dorsal fibrils; lower surface sooty-black with a central lighter pruinose spot below, sometimes extending to the margin.....*U. havaasii*
11. Thallus not fenestrate, without a pruinose area below..... 12
12. Upper surface smooth, without ridges.....*U. coriacea*
12. Upper surface ridged or reticulate..... 13
13. Thallus thick, color ± pale gray to whitish from cortical taps, reticulum coarse and prominent towards the center, towards the periphery, passing into tubercles; small epithalline secondary lobes common; lower surface almost always entirely soft velvety-black with or without an indistinct fold structure at the umbilicus, frequently ± lacunose.....*U. decussata*
13. Thallus thin with a fine prominent reticulum; lower surface unevenly and finely sooty, frequently with radial, soft folds about the umbilicus.....*U. lyngei*

Subgenus Umbilicaria
Section Velleae Frey

1. **Umbilicaria lambii** sp. nov.

Thallus plus minusve crustaceus, usque ad 10 cm. diam. et 2-3 mm. crassit., rimosoareolatus, ambitu irregulariter lobatus; superne fusco-nigrescens, subnitidus, undulatus; inferne ater, dense papillatus, trabeculis anastomosantibus fibrillosis obtectus. Soredia et isidia nulla. *Hypothallus* adpressus, radiatus, funiculis tenuibus hypharum nigrarum.

Thallus ca. 185 μ crassus. *Stratum epinecrale* irregulariter distributum, hyalinum, usque ad 3-4 μ crassum. *Cortex superior* irregulariter formatus, ca. 15 μ crassus, fuscus, cellulis plus minusve isodiametricis 4.5-6.0 μ (parietibus 0.8-1.0 μ crassis). *Stratum algarum* ca. 30 μ crassum, pro parte interruptum. Algae protococcoideae plus minusve rotundae, 8-12 μ diam. *Medulla* crassa

(ca. 120 μ), laxa, hyalina, hyphis leptodermaticis; superne strato (30 μ crasso) inspersogranulato. *Cortex inferior* 15 μ crassus, fuscus, cellulis plus minusve isodiametricis 4.0-5.6 μ diam. (parietibus ca. 1.0 μ crassis).

Apothecia numerosa, usque ad 0.7 mm. diam., sessilia, basi bene constricta, primo simplicia orbicularia margine proprio integro mediocri, deinde convoluto flexuoso; leiodisco atro, haud nitido. *Amphithecium* 60-70 μ crassum; parte exteriore 20-30 μ crassa fusca. *Hypothecium* fuscum, centro obconicum. *Hymenium* 70-90 μ altum, continuum, epithecio obscure fusco; paraphyses incoloratae, apicibus non incrassatae. Asci inflato-clavati, longit. 40, crassit. 16 μ. Sporae octonae, simplices, incoloratae, ellipsoideae vel leviter fabaceae, longit. 10-14, crassit. 3.5-6.0 μ.

Pycnidia subimmersa, 145-165 μ alta, 110-125 μ lata, muris pallide brunneis cellulis isodiametricis (3-4 μ diam.) compositis. Conidiophorae flexuosae, tenues aramosae, septatae. Conidia recta, cylindrica, 4-5 ca. 1.5 μ.

React. Chem.: Medulla $CaCl_2O_2$ et KOH immutata, etiam cum cortice.

TYPE: Collected on rock by I. M. Lamb, no. 6584, 3 August 1951, at Sunburst Lake, 2400 m., Mt. Assiniboine Provincial Park, British Columbia. Conserved in National Museum of Canada, Ottawa (CAN).

Thallus forming large crustose patches, up to at least 10 cm. across (on rock fragments seen) and becoming 2-3 mm. thick at center. *Upper surface* brown to almost black, subnitidous, uneven, undulating, marked with an irregular network of indented, wavy, black lines; becoming rimose with irregular areoles at intervals at ca. 5 mm.; marginally ± lobulate. Occasional areoles in middle of crust lift above neighboring areoles, continue growth and become lobulate as at the margin. *Lower surface* of free lobes black, coarsely papillate with branching structures extending ray-like towards the periphery and becoming fibrillose. Thallus raised above substratum (rock) by the irregular mass of branching structures which develop from the hypothallus. Hypothallus black, composed of closely adherent, radiating, branching strands ca. 0.15 mm. wide.

Thallus lobes ca. 185 μ thick when mounted in water (much thicker when in KOH due to the greatly expanded medulla). *Upper colorless zone* ca. 3-4 μ thick. *Upper cortex* 15 μ thick, brown, cells irregularly arranged, ± isodiametric, diam. 4.5-6.0 μ with rather thin walls (0.8-1.0 μ). *Algal layer* discontinuous, ca. 30 μ thick; algae protococcoid, 8-12 μ diam. *Medulla* hyaline, ca. 120 μ thick, composed of leptodermate hyphae intertwining to form

a very loose mesh; upper 30 μ opaque, densely inspersed with granules which disappear in KOH. *Lower cortex* not clearly differentiated, unevenly developed, 15 μ thick, brown; cells ± isodiametric, diam. 4.0-5.6 μ, with rather thin walls (ca. 1.0 μ).

Apothecia common, up to 0.7 mm. across, very irregular (elongated, crenate, or deeply lobed); disks plane (leiodiscs); margins thin. *Amphithecium* 60-70 μ thick, ± pallid but outer 20-30 μ brown. *Hypothecium* brown, extending down into the thallus. *Hymenium* colorless, 70-90 μ thick; epithecium brownish; paraphyses hyaline, tips not thickened; asci inflated-clavate, 40 × 16 μ; spores 8-nae, non-septate, colorless, ellipsoid to fabaceo-curved, 10-14 × 3.5-6.0 μ (often with vacuoles simulating a spurious polarilocular appearance).

Pycnidia rather common in small papillae, 145-165 × 110-125 μ; conidiophores unbranched, flexuous, septate; conidia cylindric, 4-5 × ca. 1.5 μ.

Chem. React.: Thallus cross-section KOH— and $CaCl_2O_2$—.

Distribution shown in Map 81.

Pacific Mountain System. Cascade-Sierra Mountains Province: Northern Cascade Mountains—Pugh Mt., 7150 ft. (18489). Middle Cascade Mountains—Mt. Fremont, 7100-7200 ft. (17450).

Rocky Mountain System. Northern Rocky Mountains Province: Bow Range—Mt. St. Piran, 2895 m. (*Lamb* 6401); Citadel Peak, 2750-2800 m. (*Lamb* 6552, 6555).

The thallus is less crustose in collection no. 18489, which looks like some complicated forms of *U. angulata*. The latter, however, are distinguished by their gyrodisc apothecia. The thallus characteristics of *U. lambii*, as well as the irregular apothecia with poorly developed margins, indicate the close relation of this new species to the group of *phaea-angulata-torrefacta-polyrrhiza*, a group which is best represented in western North America. A Siberian species, *U. pulvinaria* (Sav.) Frey, also belongs in this group, and from the description in Llano (1950) the thallus is similar to that of *U. lambii*, but the apothecia are actinodiscs (Scholander 1934, *pl.* III, *fig.* 5).

2. Umbilicaria angulata Tuck. Proc. Amer. Acad. 1: 266. 1848. (*Map* 73)

Pacific Mountain System. Cascade-Sierra Mountains Province: Northern Cascade Mountains—Pugh Mt., 7150 ft. (18481). Middle Cascade Mountains—Mt. Fremont, 7100-7200 ft. (17445, 17446).

Llano (1950) has reported *U. angulata* from 2450 m. on Mt. Baker, Washington.

3. *Umbilicaria vellea* (L.) Hoffm.[13] Descr. Adumbr. Pl. Lich. 2: 9. 1794. *Lichen velleus* L. Sp. Pl. 1150. 1753. (*Map* 84)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18660); Pugh Mt., 7150 ft. (18508). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7300 ft. (158).

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12600 ft. (S-2918). SANGRE DE CRISTO RANGE—Lake Peak, 2600 m. (*Bro. Arsène* 19052 in Herb. St. Michael's College, Santa Fe, New Mexico).

The only alpine record for this species, published by Llano (1950) is a collection by Darrow from the Rocky Mountain National Park, Colorado (elev. 4275 m.). Collection no. 158 was erroneously reported by Imshaug (1950) as *Dermatocarpon moulinsii*. Also, the record of *Gyrophora cirrosa* from Lake Peak, New Mexico, published by Bouly de Lesdain (1932) is *U. vellea* as noted in Llano (1950).

Section Glabrae Frey

4. *Umbilicaria torrefacta* (Lightf.) Schrad. Spicil. Fr. Germ. 1: 104. 1794. *Lichen torrefactus* Lightf. Fl. Scot. 2: 862. 1777. (*Map* 83)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17547, 17550); Moose Lake Trail, 6200-6500 ft. (17575a, 17610). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18629a); Pugh Mt., 7150 ft. (18514). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7100-7400 ft. (17390); Mt. Fremont, 7100-7200 ft. (17454).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Mt. St. Piran, 2895 m. (*Lamb* 6409, 6415); Citadel Peak, 2850 m. (*Lamb* 6558). LEWIS RANGE—Piegan Pass, 8000 ft. (8012a).

This species has been reported from the Cascade Mountains, Washington, by Howard (1937, 1950, sub *U. erosa*) and from Mt. Baker, Washington, 1800-2400 m., by Llano (1950).

5. UMBILICARIA HYPERBOREA (Ach.) Hoffm. Deutschl. Fl. 110. 1796. *Lichen hyperboreus* Ach. K. Vet. Acad. Nya Handl. 15: 89, *pl.* 2, *f.* 2. 1794. (*Map* 79)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17550, 17506); Moose Lake Trail, 6200-6500 ft. (17599, 17575). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18666, 18656, 18665a); Tiffany Mt., 8275 ft. (18728, 18753); Slate Peak, 7488 ft. (18607a, 18608, 18616a, 18574, 18626a, 18629); Pugh Mt., 7150 ft. (18504, 18514a). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7400 ft. (17367, 17390, 175); Mt. Fremont, 7100-7200 ft. (17442, 17435, 17439, 17454, 17449a, 17426a, 17425).

Intermontane Plateaus. COLUMBIA PLATEAUS PROVINCE: WALLOWA MOUNTAINS—Eagle Cap, 9675 ft. (18821, 18861, 18830). COLORADO PLA-

[13] The combination is usually credited to Acharius (1794, p. 101). Acharius, however, does not recognize the genus *Umbilicaria* in this publication.

TEAUS PROVINCE: SAN FRANCISCO MOUNTAINS—Agassiz Peak, 12340 ft. (12723, 17881b).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Mt. St. Piran, 2895 m. (*Lamb* 6415, 6416); Little Mt. Richardson, 2700 m. (*Lamb* 6319); Twin Cairns Mt., 2700 m. (*Lamb* 6498); Citadel Peak, 2850 m. (*Lamb* 6556, 6558). LEWIS RANGE—Appekunny Basin, 6000 ft. (5628, 5609b, 5623a); Swiftcurrent Pass, 7000 ft. (6133, 6203, 6130, 6132a); Goat Mt., 8800 ft. (6539, 6540a, 6500a); Dawson Pass, 7500-8000 ft. (8618, 8686); Piegan Pass, 8000 ft. (7978, 8012); Garden Wall above Grinnell Glacier, 7900 ft. (8519); Scenic Point, 7000 ft. (8881b). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18805). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9706, 9708). WIND RIVER RANGE—Mt. Lester, 11700 ft. (19058). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 11500 ft. (S-1608); above Fool Creek, 11500 ft. (S-1681). PARK RANGE—Wheeler Lake, 12300 ft. (S-2785, S-2779); Hoosier Ridge, 13000 ft. (19009). SAWATCH MOUNTAINS—Independence Pass, 10100 ft. (11577); Cottonwood Pass, 12700 ft. (11670); Lake Pass, 12225 ft. (11795, 11803a). ELK MOUNTAINS—Conundrum Pass, 11700 ft. (S-5839); East Maroon Pass, 11850 ft. (10663, 10696). SAN JUAN MOUNTAINS—Engineer Mt. to Gravel Mt. along ridge, 13000 ft. (17119, 17132, 17135). SANGRE DE CRISTO RANGE—Wheeler Peak, 13151 ft. (12299); Lake Peak, New Mexico, 3700 m. (*Bro. Arsène* 19913) in Herb. St. Michael's College, Santa Fe, New Mexico).

Alpine records of *Umbilicaria hyperborea* have been published from British Columbia and Alberta by Fink (1919), from the Cascade Mountains of Washington by Howard (1937, 1950) and from New Mexico by Bouly de Lesdain (1932, sub *U. hyperborea;* 1942, sub *U. intermedia*). Also, Llano (1950) has published alpine records of this species from Mt. Fairview in the Canadian Rocky Mountains (2250-2790 m.), the Olympic Mountains in Washington (1800-1950 m.), Mt. Rainier in Washington (2025 m.), Mt. Baker in Washington (1800-2400 m.), the alpine summit of Mt. Hood in Oregon, various localities in Colorado (2700-3900 m.) Lake Peak in New Mexico and the San Francisco Mountains in Arizona (3600 m.).

The polyphyllous forms of *U. hyperborea* frequently have very scant vermiform markings and might be confused with *U. polyphylla*. All the alpine material seen, however, seemed better referable to *U. hyperborea*. Dahl (1950, p. 120) described f. *prolificans* Oliv. as "a formae [*sic*] converging towards *U. polyphylla* from which it is distinguished by a lighter underside and by lacking the rounded lobes of *U. polyphylla*."

6. UMBILICARIA DEUSTA (L.) Baumg. Fl. Lips. 571. 1790. *Lichen deustus* L. Sp. Pl. 1150. 1753. (*Map 77*)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Pugh Mt., 7150 ft. (18484).

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Upper Green Lakes, north of Kiowa Peak, 11500 ft. (S-1442); above Fool Creek, 11500 ft. (S-1678).

Llano (1950) has reported *U. deusta* from elevations of 3510-4050 m. in Colorado.

Section Anthracinae Frey

7. **Umbilicaria coriacea** nom. nov. *Gyrophora rigida* DR. Ark. Bot. 19(12): 3. 1925. *Umbilicaria rigida* (DR.) Frey, Hedwigia 71: 117. 1931 (*non U. rigida* Hoffm. Deutschl. Fl. 2: 112. 1796). (*Map* 74)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17582). CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17449, 17433, 17440, 17450).

The apothecia in collection no. 17450 are becoming omphalodisc. Llano (1950, sub *Agyrophora rigida*) has reported this species from the Olympic Mountains at elevations of 1950-2100 meters.

UMBILICARIA LYNGEI Schol. Nytt Mag. Naturv. 75: 19. 1934. This species has not been collected in the present study but it has been reported by Llano (1950) from Mt. Hood in Oregon (2100-2700 m.) and from Mt. Baker in Washington. These collections are without apothecia, as usual in this species and they are, therefore, difficult to separate from *U. decussata*. The diagnostic characters are given at length in the key.

Section **Decussatae** (Schol. *ex.* Llano) n. comb.

Omphalodiscus section Decussatae Schol. *ex* Llano, Mon. Umbilic. 76. 1950.

8. UMBILICARIA DECUSSATA (Vill.) Zahlbr. Cat. Lich. Univ. 8: 490. 1932. *Lichen decussatus* Vill. Hist. Pl. Dauphin. 3: 964, *pl.* 55. 1789. (*Map* 76)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18671); Slate Peak, 7488 ft. (18560a). SIERRA NEVADA—Mt. Whitney, 14495 ft. (17955).

Intermontane Plateaus. COLUMBIA PLATEAUS PROVINCE: WALLOWA MOUNTAINS—Eagle Cap, 9675 ft. (18830). COLORADO PLATEAUS PROVINCE: SAN FRANCISCO MOUNTAINS—Agassiz Peak, 12340 ft. (17887, 17881a, 17910); no specific peak, 12000 ft. (S-3708).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18803a, 18807). MIDDLE ROCKY MOUNTAINS PROVINCE: BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19151, 19175). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Trail Ridge, 12000 ft. (11208); Mt. Evans, 12600-14260 ft. (11048, 11091, S-2926); Pikes Peak, 13300 ft. (S-5693, 11956, 11957). PARK RANGE—Hoosier Ridge, 13000 ft. (19004, 19020). SAWATCH MOUNTAINS—Mt. Massive, 12750 ft. (11884, 11907, 11915, 11932); Lake Pass, 12225 ft. (11780); Independence Pass, 10100 ft. (11579); Cottonwood Pass, 12700 ft. (11661, 11670). ELK MOUNTAINS—Mt. Belleview, 12500 ft. (10532); East Maroon Pass, 11850 ft. (10660, 10662); White Rock Mt. (10998). SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16997a); ridge between Engineer and Gravel Mtns., 13200 ft. (17074a, 17069). SANGRE DE CRISTO RANGE—West Spanish Peak, 13623 ft. (12068).

Alpine records of *U. decussata* have been published from Mt. Shasta in California by Herre (1950) and from the San Francisco Mountains in Arizona by Llano (1950).

Umbilicaria decussata is usually not as abundant as either *U. virginis* or *U. krascheninnikovii*. Although it is usually found without apothecia, it is easily recognized by the absence of rhizinae, the black undersurface with a paler marginal zone and the characteristic reticulations on the upper surface. In the San Juan Mountains of Colorado, however, it may be hard to separate from *U. krascheninnikovii* because the latter frequently has a darker ventral surface.

9. UMBILICARIA KRASCHENINNIKOVII (Sav.) Zahlbr. Cat. Lich. Univ. 10: 405. 1939. *Gyrophora krascheninnikovii* Sav. Bull. Jard. Imp. Bot. Pierre le Grand 14: 117. 1914. (*Map* 80)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17468, 17460); Anvil Rock, Mt. Rainier, 9600 ft. (2080). SOUTHERN CASCADE MOUNTAINS—Mt. Shasta, 13800 ft. (18355, 18353, 18349); Lassen Peak, 10466 ft. (18332, 18327). SIERRA NEVADA—Mt. Rose, Carson Range, 10775 ft. (18306, 18320); ridge from Sonora Pass to Leavitt Peak, 11200 ft. (18265, 18260, 18266); Mammoth Peak, 12225 ft. (18214); Mt. Dana, 13050 ft. (18161, 18163, 18164, 18180); Parker Pass, 11800 ft. (18238, 18222, 18236, 18239); Bishop Pass, 12000 ft. (18128, 18129); Piute Pass, 12000 ft. (18047, 18048, 18055, 18077, 18087); Kearsarge Pass, 11823 ft. (17994, 18019, 18020); Mt. Whitney, 14495 ft. (17978, 17981, 17986).

Intermontane Plateaus. COLUMBIA PLATEAUS PROVINCE: WALLOWA MOUNTAINS—Eagle Cap, 9675 ft. (18821, 18845, 18826, 18827, 18830, 18839). COLORADO PLATEAUS PROVINCE: LA SAL MOUNTAINS—Mt. Mellenthin, 12890 ft. (16896). SAN FRANCISCO MOUNTAINS—Agassiz Peak, 12340 ft. (17878, 17888, 17910, 12730).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Mt. St. Piran, 2895 m. (*Lamb* 6415); Silvertip Mt., 2850 m. (*Lamb* 6355); Quartz Hill, 2650 m. (*Lamb* 6476). LEWIS RANGE—Appekunny Basin, 6000 ft. (5603, 5623, 5626, 5628a); Altyn Peak, 7500 ft. (5670a); Swiftcurrent Pass, 7000 ft. (6132, 6227, 6133a, 6215a); Appekunny Mt., 8500 ft. (6253, 6273); Scenic Point, 7600 ft. (8829, 8834a, 8837a, 8846a, 8881a); Dawson Pass, 7500-8000 ft. (8631, 8676, 8678, 8609); Reynolds Mt., 7700 ft. (7767a). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18784, 18799, 18803, 18813). PIONEER MOUNTAINS—Hyndman Pass, 10200-11100 ft. (16630, 16629, 16651, 16601, 16600, 16606). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9633, 9794, 9634, 9734, 9700, 9673, 9571). TETON RANGE—pinnacle above Surprise Lake, 9900 ft. (9222, 9225, 9229); Summit Divide along Indian Paintbrush Trail, 10600 ft. (9201, 9157a); Static Peak, 11294 ft. (9328). WIND RIVER RANGE—Mt. Lester, 11700 ft. (19100). BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19127, 19135, 19180). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18903, 18907). FRONT RANGE—Trail Ridge, 12000 ft. (11189, 11235a); Mt. Evans, 14260 ft. (11062, 11057, S-5633); Little Echo Lake, Gilpin County (S-2994). PARK RANGE—Wheeler Lake, 12300 ft. (S-2783); Hoosier Ridge, 13000 ft. (18960). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11529, 11535, 11533); Independence Pass, 10100 ft. (11555, 11561); Cottonwood Pass,

12700 ft. (11625, 11668, 11669); Mt. Massive, 12750 ft. (11884, 11892a, 11932). Elk Mountains—Mt. Belleview, 12500 ft. (10535). San Juan Mountains—ridge between Engineer & Gravel Mts., 13000-13200 ft. (17092, 17110a, 17123); Blue Lake Pass, 12500 ft. (17021a, 16979). San Miguel Mountains—Black Face, 12200 ft. (17187). Sangre de Cristo Range—Trinchera Peak, 13546 ft. (12198); Wheeler Peak, 13151 ft. (12247, 12255, 12266, 12275a, 12287a); Gold Hill, 12660 ft. (12361, 12389, 12391).

Alpine records of *U. krascheninnikovii* have been published from Mt. Adams in Washington by Howard (1955) and from the summit of Mt. Rose in Nevada by Herre (1911, 1913, sub *Gyrophora reticulata*). Llano (1950) has also published alpine records of this species from the Canadian Rocky Mountains (2700 m.), Mt. Adams in Washington (2100-2700 m.), Mt. Hood in Oregon (2100-2700 m.), Mt. Reynolds in Glacier National Park, Montana (2160 m.), Mt. Rose in Nevada (3240), Baldy Peak in New Mexico (3600 m.), San Francisco Mountains in Arizona (3600 m.) and various localities in Colorado (3570-3750 m.).

This species is usually pale below but the material from the San Juan Mountains approaches *U. decussata, i.e.,* is dark below and is more or less reticulate above with apothecia rare or absent.

Some of the above material represents **Umbilicaria krascheninnikovii** var. **darrowii** (Frey) comb. nov. (*Umbilicaria decussata* var. *darrowii* Frey, Bericht. Schweiz. Bot. Ges. 45: 224-225. 1936). This variety may be separated by a brown, usually nitid upper surface and the usual presence of rhizinae below. Llano does not mention the rhizinae for this variety, but they are present on the type collection and on most of the other collections seen. The type comes from California, not Nevada as stated by Llano (1950). Rhizinae are rarely found in var. *krascheninnikovii.*

10. Umbilicaria virginis Schaer. *in* Desor, Bibl. Univ. Genève II. 36: 153. 1841. (*Map* 85)

Pacific Mountain System. Pacific Border Province: Olympic Mountains—summit of Mt. Olympus, 8200 ft. (*Frye* 44 in MICH.) Cascade-Sierra Mountains Province: Northern Cascade Mountains—Windy Peak, 8345 ft. (18665); Tiffany Mt., 8275 ft. (18740); Slate Peak, 7488 ft. (18622, 18613, 18626); Pugh Mt., 7150 ft. (18469). Middle Cascade Mountains—Mt. Fremont, 7100-7200 ft. (17443, 17426); Anvil Rock, Mt. Rainier, 9600 ft. (2072, 2076, 2078, 2080a, 2083, 2086, 2089, 2090, 2093, 2096); ridge between North and Middle Sisters, 9000 ft. (18357, 18359, 18360). Sierra Nevada—Mt. Whitney, 14495 ft. (17955); ridge from Sonora Pass to Leavitt Peak, 11200 ft. (18252); Mammoth Peak, 12225 ft. (18213); Piute Pass, 12000 ft. (18043, 18048a).

Intermontane Plateaus. Columbia Plateaus Province: Wallowa Mountains—Eagle Cap, 9675 ft. (18834). Basin and Range Province: Snake Range—Wheeler Peak, 13061 ft. (17322, 17313, 17314, 17329, 17332, 17323). Colorado Plateaus Province: La Sal Mountains—Mt. Mellenthin, 12890 ft. (16895, 16896, 16908, 16933, 16882). San Francisco Mountains—San Francisco Peaks, 12000 ft. (S-2968); Agassiz Peak, 12340 ft. (12715, 12725a, 12726, 12727, 17870, 17881, 17922).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Altyn Peak, 7500 ft. (5673, 5680, 5670); Swiftcurrent Pass, 7000 ft. (6174); Appekunny Mt., 8500 ft. (6297, 6253a, 6273a); Goat Mt., 8800 ft. (6489, 6540, 6528, 6543a); Swiftcurrent Mt., 8300 ft. (7840, 7862, 7894, 7887a, 7918); Dawson Pass, 7500-8000 ft. (8615, 8651, 8663, 8613, 8614, 8631a); Scenic Point, 7600 ft. (8802, 8828, 8834, 8846, 8856); Siyeh Pass, 8200 ft. (8959, 9042); Piegan Pass, 8000 ft. (8036); Garden Wall above Grinnell Glacier, 8000 ft. (8468). PIONEER MOUNTAINS—Hndyman Pass, 10200-11100 ft. (16638, 16626, 16630, 16651, 16655, 16605). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9599). WASHBURN RANGE—Mt. Washburn, 10300 ft. (9503, 9457, 9505, 9534). TETON RANGE—Static Peak, 11294 ft. (9305, 9321, 9350, 9355, 9296, 9375a); Summit Divide, Indian Paintbrush Trail, 10600 ft. (9201a). WIND RIVER RANGE—Mt. Lester, 11700 ft. (19062, 19066, 19097). BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19117, 19175). UINTA MOUNTAINS—Marsh Peak, 12219 ft. (17297, 17277, 17291); Leidy Peak, 12013 ft. (17197, 17259, 17205, 17222, 17223, 17236, 17237); Bald Mt., 11300-11947 ft. (16720, 16793, 16798, 16775). WASATCH MOUNTAINS—Mt. Baldy, 11049 ft. (16807, 16801, 16804); Mt. Timpanogos, 12000 ft. (16699, 16677, 16693, 16688). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18876, 18885, 18905, 18907, 18908). FRONT RANGE—Trail Ridge, 12000 ft. (11187a, 11196, 11201, 11245); Longs Peak, 14250 ft. (S-5978, S-5979); Buchanan Pass, 11700 ft. (S-1689); Mt. Evans, 11500-14260 ft. (11062, 11077, 11073, 11097, 11125, 11134, S-907, S-284, S-1616); Little Echo Lake, Gilpin County (S-2993); Pikes Peak, 13000-14100 ft. (S-5676, S-5692, 11952, 11987a, 12000a, 11940, 11947a). PARK RANGE—Hoosier Ridge, 12000-13000 ft. (S-4561, 18960, 19006, 19025, 19046); Wheeler Lake, 12300 ft. (S-2784); Loveland Pass, 12500 ft. (S-2703); Grays Peak, 14274 ft. (S-61). SAWATCH MOUNTAINS—Mt. Massive, 12750-14418 ft. (11877, 11879, 11884, 11892a, 11898, 11932); Independence Pass, 12900 ft. (11589, 11602, 11608, 11591a, 11595a). ELK MOUNTAINS—Gothic Mt., 12646 ft. (10418); Mt. Belleview, 12500 ft. (10500, 10507, 10519, 10534a, 10540a); Virginia Ridge, 12300-12400 ft. (10570a, 10579, 10586a); East Maroon Pass, 11850 ft. (10675, 10679); White Rock Mt., 13000 ft. (10998). SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16987, 16997, 17021, 16979); ridge between Engineer and Gravel Mts., 13000-13200 ft. (17116, 17074, 17092a, 17096, 17109, 17110). SAN MIGUEL MOUNTAINS—Black Face, 12200 ft. (17187a). SANGRE DE CRISTO RANGE—West Spanish Peak, 13623 ft. (12028, 12034, 12051); Trinchera Peak, 13546 ft. (12142, 12167, 12182a, 12198); Wheeler Peak, 13151 ft. (12242, 12264, 12275a, 12291a); Gold Hill, 12660 ft. (12346, 12350a).

Llano (1950) has reported alpine records of this species from the Olympic Mountains in Washington (2160-2460 m.), Mt. Rainier in Washington (2400 m.), Mt. Adams in Washington (2190-2700 m.), Mt. Hood in Oregon (2100-2700 m.), Lassen Peak in California (3135 m.) Mt. Rose in Nevada (3240 m.), Sonora Peak in California (3429 m.), Mt. Whitney in California (4348 m.), San Francisco Mountains in Arizona (3600 m.), Mt. St. Piran in the Canadian Rocky Mountains (2700 m.), Glacier National Park in Montana (2100-2400 m.), Teton Range in Wyoming (3600 m.), Uinta Range in Utah (3450-3900 m.) and various localities in Colorado (3300-4350 m.). Alpine records of this species have also been reported from the summit of Mt. Rose in Nevada (Herre, 1911, 1913, sub *Gyrophora rugifera*),

Pikes Peak in Colorado (Whitfield, 1933, sub *U. rugifera*), Mt. Shasta in California (Herre, 1950, sub *U. rugifera*), Teton Range in Wyoming (Willey, 1873, sub *U. rugifera*), Olympic Mountains in Washington (Fink, 1919, sub *U. rugifera* & Howard, 1950), Mt. Hood in Oregon (Tuckerman, 1882, sub *U. rugifera*), and Mt. Adams in Washington (Howard, 1955).

This is a high alpine species which was originally described from the summit of the Jungfrau in Europe. The size of this species is extremely variable. In our alpine areas it is usually very small (<4 cm.), but in Norway and Ellesmereland Lynge & Scholander (1932) reported it to be about 25 cm., in Novaya Zemlya 10-11 cm. but in Greenland only 6 cm.

Section Umbilicaria (= Polymorphae Frey)

11. UMBILICARIA CYLINDRICA (L.) Del. *in* Duby, Bot. Gall. 2: 595. 1830. *Lichen cylindricus* L. Sp. Pl. 1144. 1753. (*Map* 75)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Pugh Mt., 7150 ft. (18470, 18498). MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17439); Burroughs Mt., 7100-7400 ft. (17384).

Fink (1907, 1919) has reported alpine collections of this species from the Lake Louise area in Alberta. Llano (1950) has reported it from Utah, Pikes Peak in Colorado, and Mt. Rainier in Washington. The Utah collection, cited by Llano is, however, *U. virginis*. The Colorado collection, cited by Llano, is also *U. virginis* and was in fact annotated in the herbarium of Cornell University as *Omphalodiscus virginis* by Llano in 1947.

This species may sometimes be confused with *U. virginis* but the entirely different type of apothecium, when present, prevents confusion. Also, *U. cylindrica* usually has a mottled, watery appearance, and the rhizinae are distinctly marginal.

12. UMBILICARIA PROBOSCIDEA (L.) Schrad. Spicil. Fl. Germ. 1: 103. 1794. *Lichen proboscideus* L. Sp. Pl. 1150. 1753. (*Map* 82)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17584, 17605). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18560, 18607, 18616, 18630, 18632, 18639; Pugh Mt., 7150 ft. (18501a). MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17477).

Fink (1907) has reported this species from alpine localities in the Canadian Rocky Mountains. Llano (1950) has reported it from Mt. St. Piran in the Canadian Rocky Mountains (2250-2790 m.), the Olympic Mountains in Washington (1800-1833 m.) and Colorado. The Colorado collection (MICH: *Plitt*) cited by Llano, however, is *U. virginis*.

13. UMBILICARIA HAVAASII Llano, Mon. Umbil. 136. 1950, nom. nov. for *Gyrophora fuliginosa* Hav. *in* Lynge, Vidensk. Skrift.

I. Mat.-nat. Klasse. 7: 96. 1921. *Umbilicaria fuliginosa* (Hav. *in* Lynge) Zahlbr. Cat. Lich. Univ. 8: 491. 1932 [*non* Pers. Ann. Wetter. Ges. 2(1): 19. 1810.]. (*Map* 78)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Pugh Mt., 7150 ft. (18501). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7100-7400 ft. (17349).

Llano (1950) has reported *U. havaasii* from alpine areas in the Olympic Mountains, Washington (1800-2100 m.).

PARMELIACEAE

PARMELIA

1. Rhizinae absent below 2
1. Rhizinae present below 9
2. Thallus with medullary cavity 3
2. Thallus solid, without medullary cavity 7
3. Sorediate 4
3. Not sorediate 6
4. Thallus diffused-sorediose (isidioid) over upper surface; mottled brown and gray with black margins ..... *P. austerodes*
4. Thallus with soralia on margins 5
5. Soralia labrose; thallus PD+ (red) ..... *P. physodes*
5. Soralia capitate; thallus PD— ..... *P. bitteri*
6. Laciniae mottled brown and gray; thallus PD— ..... *P. subobscura*
6. Laciniae swollen, gray; with frequent apical perforations; thallus PD+ or PD— ..... *P. enteromorpha*
7. Thallus gray, irregularly swollen, PD— (or belatedly yellow) ..... *P. intestiniformis*
7. Thallus dark brown or almost black 8
8. Thallus irregularly swollen, PD+ (strong yellow immediately); if crustose-areolate, marginal laciniae are lobate ..... *P. alpicola*
8. Thallus not irregularly swollen, PD—; laciniae filamentous; if crustose-areolate, marginal laciniae are filamentous ..... *Alectoria minuscula*
9. Thallus brown or black 10
9. Thallus not brown or black 15
10. Sorediate or isidiate 11
10. Neither sorediate nor isidiate 12
11. Thallus with scattered soralia on upper surface ..... *P. disjuncta*
11. Thallus with scattered cylindrical isidia, ± pruinose ..... *P. infumata*
12. Laciniae ± convex 13
12. Laciniae plane or with ± concave areas 14
13. Laciniae narrow, imbricate to ± continuous, PD+ (yellow) ..... *P. alpicola*
13. Laciniae discrete, numerous pycnidia on upper surface, ends of laciniae rounded, shiny ..... *P. stygia*
14. Laciniae large ..... *P. pulla*
14. Laciniae imbricated, small ..... *P. panniformis*
15. Thallus yellow-green ..... *P. stenophylla*
15. Thallus cinereous 16
16. Sorediate or isidiate 17
16. Neither sorediate nor isidiate ..... *P. omphalodes*

17. Cylindrical isidia scattered over the thallus.....*P. saxatilis*
17. Fissure shaped soralia scattered over the thallus.....*P. sulcata*

Subgenus Hypogymnia Nyl.
Section Tubulosae Bitter

1. PARMELIA AUSTERODES Nyl. Flora 64: 537. 1881, nom. nov. for *Parmelia physodes* var. *obscurata* Ach. Syn. Lich. 218. 1814. (*Map* 33)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17437).

Intermontane Plateaus. COLORADO PLATEAUS PROVINCE: LA SAL MOUNTAINS—Mt. Mellenthin, 12890 ft. (16882, 16885).

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: SAWATCH MOUNTAINS—Mt. Massive, 12750 ft. (11894). SANGRE DE CRISTO RANGE—Gold Hill, 12660 ft. (12406).

This is a corticolous species of the forested region occasionally found over turf in alpine areas.

2. PARMELIA ENTEROMORPHA Ach. Meth. Lich. 252. 1803. (*Map* 36)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17593, PD−; 17602, PD+; 17611, PD+).

Parmelia enteromorpha is a very variable species in western America and it may well represent a complex of several taxa. *Parmelia duplicata* (Sm. *in* Ach.) Ach. represents a narrow lobed variation of *P. enteromorpha* corresponding to *P. vittata*. The medullary hyphae surrounding the cavity are sometimes brown and sometimes white. The white layer is frequently, but not always, associated with the narrow-lobed variation. The PD reaction is also variable. Some specimens are PD+ (red), as in *P. physodes*, but others are PD—. Asahina has called the negative ones f. *inactiva*. I have been unable so far, however, to associate these various characters in any way to recognize separate taxa, although certain field populations appear clearly distinct.

3. PARMELIA BITTERI Lynge, Vidensk. Skrift. I. Mat.-naturv. Klasse 1921(7): 138. 1921. [descr. sub *Parmelia obscurata* (Ach.) Bitter, Hedwigia 40: 214, *f.* 3, b-d, 5, 12, 21. 1901.] (*Map* 34)

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: SAWATCH MOUNTAINS—Cottonwood Pass, 12700 ft. (11665).

Hale & Culberson (1956) do not include this species in their checklist of North American lichens. It has been reported, however, from Hermit Peak in northern New Mexico by Bouly de Lesdain (1932), and I have seen material from Lake Agnes (near Lake Louise) at an elevation of 2300 m. in the Canadian Rocky Mountains (*Lamb* 6286).

This species is usually referred to in the literature as *P. obscurata* (Ach.) Bitter. Nomenclaturally, however, *P. obscurata* is a synonym of *P. austerodes* because *P. austerodes* was originally published by Nylander as a *nomen novum* for *P. physodes* var. *obscurata* Ach. Bitter, unfortunately, misinterpreted the Acharian taxon, and Lynge was the first to provide a valid name for the species described by Bitter.

4. PARMELIA PHYSODES (L.) Ach. Meth. Lich. 250. 1803. *Lichen physodes* L. Sp. Pl. 1144. 1753. (*Map* 41)

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Piegan Pass, 8000 ft. (8002).

This species is very common in the forested areas but has only been collected once above timberline. The above cited specimen has typical labriform soralia.

5. PARMELIA SUBOBSCURA Wain. Ark. Bot. 8(4): 33. 1909 (*Map* 46)

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE. FRONT RANGE—Trail Ridge, 12000 ft. (11231); Mt. Evans, 12900 ft. (11137).

A characteristic feature of this species is the small, almost isidioid growths towards the center of the thallus. This gives the laciniae the appearance of being papillate, as observed by Lynge and Scholander (1932).

Section Solidae Bitter

6. PARMELIA INTESTINIFORMIS (Vill.) Ach. Meth. Lich. 253. 1803. *Lichen intestiniformis* Vill. Hist. Pl. Dauphin. 3: 947, *pl.* 55. 1789. (*Map* 38)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17508, 17547a). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18687, 18695); Tiffany Mt., 8275 ft. (18707); Slate Peak, 7488 ft. (18627, 18629). MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17424, 17448, 17475).

Intermontane Plateaus. COLORADO PLATEAUS PROVINCE: LA SAL MOUNTAINS—Mt. Mellenthin, 12890 ft. (16912).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Silvertip Mt., 2800 m. (*Lamb* 6348); Mt. St. Piran, 2895 m. (*Lamb* 6413, 6408); Redoubt Mt., 2830 m. (*Lamb* 6426); Quartz Hill, 2800 m. (*Lamb* 6463, 6472, 6474); Citadel Peak, 2850 m. (*Lamb* 6557). LEWIS RANGE—Altyn Peak, 7500 ft. (5690); Swiftcurrent Pass, 7000 ft. (6143, 6168a, 6201); Appekunny Mt., 8500 ft. (6246); Goat Mt., 8800 ft. (6519, 6545); Dawson Pass, 7500-8000 ft. (8619, 8623); Scenic Point, 7600 ft. (8800); Reynolds Mt., 7700 ft. (7763); Piegan Pass, 8000 ft. (7995); Garden Wall above Grinnell Glacier, 8000 ft. (8434). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18775, 18777). MIDDLE ROCKY MOUNTAINS

Province: Beartooth Range—Beartooth Pass, 11000 ft. (9794a). Teton Range—Summit Divide, Indian Paintbrush Trail, 10600 ft. (9165). Big Horn Mountains—Loaf Mt., 11000 ft. (19166). Uinta Mountains—Marsh Peak, 12219 ft. (17261). Southern Rocky Mountains Province: Medicine Bow Mountains—Medicine Bow Peak, 12000 ft. (18921). Front Range—Trail Ridge, 12000 ft. (11188, 11201, 11245, 11254, S-2041); Longs Peak, 12600 ft. (S-10855); Mt. Evans, 12600-14260 ft. (11045, 11061, 11071, 11077, 11098, S-1596, S-2923); Pikes Peak, 13300-14100 ft. (S-5670, S-5691, 11941, 11948a, 11950a, 11957, 11964, 11968); Upper Green Lakes, north of Kiowa Peak, 11500 ft. (S-1448). Park Range—Wheeler Lake, 12300 ft. (S-2730); Hoosier Ridge, 13000 ft. (19028, 19029, 19035). Sawatch Mountains—Independence Pass, 10100 ft. (11539, 11550, 11558); Cottonwood Pass, 12700 ft. (11629a, 11651); Lake Pass, 12225 ft. (11769); Mt. Massive, 12750-14418 ft. (11872, 11911, 11925). Elk Mountains—Mt. Belleview, 12500 ft. (10528); East Maroon Pass, 11850 ft. (10661, 10668, 10714); White Rock Mt., 13000 ft. (10992). San Juan Mountains—Blue Lake Pass, 12500 ft. (16976, 17037, 17046); ridge between Engineer and Gravel Mtns., 13200 ft. (17079, 17080, 17091, 17096a). San Miguel Mountains—Black Face, 12200 ft. (17178). Sangre de Cristo Range—West Spanish Peak, 13623 ft. (12035, 12036, 12050, 12069, 12070); Trinchera Peak, 13546 ft. (12142, 12176, 12179a, 12183); Wheeler Peak, 13151 ft. (12242, 12296); Gold Hill, 12660 ft. (12400, 12404).

This species differs from *P. encausta* not only in its general appearance but in its negative or only slight PD reaction. *Parmelia encausta* is PD+ (intense red). All of the alpine material cited above was PD— (or only belatedly turning somewhat yellow). Some non-alpine collections, however, from South Navarre Peak near Lake Chelan, Washington, were PD+ (cinnabar).

Subgenus Parmelia

Section Melaenoparmelia Zahlbr.

7. Parmelia stygia (L.) Ach. Meth. Lich. 203. 1803. *Lichen stygius* L. Sp. Pl. 1143. 1753. (*Map* 45)

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17511).

Rocky Mountain System. Northern Rocky Mountains Province: Bow Range—Eagle Mt., 2900 m. (*Lamb* 6453). Lewis Range—Appekunny Basin, 6000 ft. (5609, 5621, 5645, 5646, 5647a); Appekunny Mt., 8500 ft. (6258, 6277, 6285).

Alpine records of *P. stygia* have been published from the Cascade Mountains in Washington (Howard, 1937, 1950) and the Canadian Rocky Mountains (Fink, 1907).

Parmelia stygia is PD+ but the above collections were PD—. They appear to represent, therefore, var. *septentrionalis* Lynge. The laciniae are convex, rather than plane, and are shiny.

In collection no. 17511 the thallus is more or less crustose-areolate in the center and the cortex was studied to see if it might

be an *Alectoria*. Many herbarium specimens of *P. stygia* from western America are actually a flattened form of *Alectoria minuscula*.

8. PARMELIA ALPICOLA Th. Fr. Nov. Act. Reg. Soc. Sci. Upsal. III. 3: 157. 1861 (p. 57 in reprint dated 1860). (*Map* 32)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18682, 18692); Tiffany Mt., 8275 ft. (18759); Pugh Mt., 7150 ft. (18469, 18474, 18502, 18506). MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17441, 17478).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Little Mt. Richardson, 2830 m. (*Lamb* 6333).

Alpine records have been published from the Canadian Rocky Mountains (Fink, 1907, 1919) and Lake Peak in New Mexico (Bouly de Lesdain, 1932, sub *P. atrofusca*). The New Mexican record seems doubtful, but I have not seen the collection.

Parmelia alpicola is placed here in the section Melaenoparmelia instead of the subgenus Hypogymnia because of the chemical content and type of cortex, as demonstrated by Krog (1950) and Dahl (1952).

9. PARMELIA PULLA (Schreb.) Ach. Syn. Lich. 206. 1814. *Lichen pullus* Schreb. Spicil. Fl. Lipsiens. 131. 1771. (*Map* 42)

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Piegan Pass, 8000 ft. (8051, 8079).

This species is usually referred to in the literature as *P. prolixa* (Ach.) Röhl. The epithet *prolixa*, however, was first used as a species in 1867 by Malbranche (Bull. Soc. Amis Sci. Natur. Rouen 3: 473.).

10. PARMELIA PANNIFORMIS (Nyl.) Wain. Meddel. Soc. Faun. Fl. Fenn. 6: 124. 1881. *Parmelia olivacea* var. *panniformis* Nyl. Herb. Mus. Fenn. 83. 1859. (*Map* 40)

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Reynolds Mt., 7700 ft. (7737).

The above material occurred on soil and/or moss. Zahlbruckner (1930) treated *P. panniformis* (Nyl.) Wain. as a later homonym of *P. panniformis* (Ach.) Röhl. This is not true, however, because Röhling (Deutschl. Fl. ed. 2. 3(2): 102. 1813) did not treat *panniformis* as a species. Röhling wrote "*P. omphalodes* β *P. panniformis*" and thus clearly indicated varietal rank.

11. PARMELIA INFUMATA Nyl. Flora 58: 359. 1875. (*Map* 37)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18562, 18598, 18620).

Sierra Nevada—Bishop Pass, 12000 ft. (18135); Mt. Whitney, 14495 ft. (17942).

Rocky Mountain System. Middle Rocky Mountains Province: Beartooth Range—Beartooth Pass, 11000 ft. (9583). Wind River Range—Mt. Lester, 11700 ft. (19072, 19077). Big Horn Mountains—Loaf Mt., 11000 ft. (19159). Southern Rocky Mountains Province: Park Range—Hoosier Ridge, 13000 ft. (19007, 19018). Elk Mountains—White Rock Mt., 13000 ft. (11001, 11013, 11014, 11017). San Juan Mountains—ridge between Engineer and Gravel Mtns., 13200 ft. (17066, 17073). Sangre de Cristo Range—Wheeler Peak, 13151 ft. (12254a).

The isidia frequently break off and leave bare, white, decorticated spots scattered over the thallus. A pruina is usually found over a part of the thallus but it may occasionally be absent. The above cited material was collected over soil, moss and rock.

12. Parmelia disjuncta Erichs. Ann. Mycol. 37: 78. 1939. [*nom. nov.* for *Parmelia sorediata* var. *coralloidea* Lynge, Rep. Sci. Results Norweg. Exped. Novaya Zemlya 1921. 43: 200. 1928 & *Parmelia granulosa* Lynge *in* Lynge & Schol. Skr. om Svalbard og Ishavet 41: 74, *pl.* 6, *f.* 4. 1932 (*non* Mart. Fl. Crypt. Erlang. 219. 1817).] (*Map* 35)

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17521).

Intermontane Plateaus. Colorado Plateaus Province: La Sal Mountains—Mt. Mellenthin, 12890 ft. (16889).

Rocky Mountain System. Northern Rocky Mountains Province: Lewis Range—Piegan Pass, 8000 ft. (8065, 8086). Southern Rocky Mountains Province: Park Range—Hoosier Ridge, 13000 ft. (18970). Sawatch Mountains—Independence Pass, 10100 ft. (11554); Cottonwood Pass, 12700 ft. (11642, 11663, 11667); Mt. Massive, 12750 ft. (11895). Elk Mountains—Gothic Mt., 12646 ft. (10420); White Rock Mt., 13000 ft. (10992); East Maroon Pass, 11850 ft. (10652). San Juan Mountains—ridge between Engineer and Gravel Mtns., 13200 ft. (17057, 17073, 17078).

Lynge and Scholander (1932) called attention to the fact that in the arctic the soredia may be poorly developed, and *P. disjuncta* may then be confused with *P. prolixa*. Lynge calls *P. disjuncta* west arctic and *P. sorediata* east arctic in distribution.

The soredia in *P. disjuncta* are usually confluent and blackened whereas in *P. sorediata* they are discrete, white, terminal and frequently appear stipitate.

Section Xanthoparmelia (Wain.) Zahlbr.

13. Parmelia stenophylla (Ach.) Heugel, Correspondzbl. naturf. Verein. Riga 8: 109. 1855. *Parmelia conspersa* var. *stenophylla* Ach. Meth. Lich. 206. 1803. (*Map* 44)

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17536a, 17540). Cascade-Sierra Moun-

TAINS PROVINCE: SIERRA NEVADA—Kearsarge Pass, 11823 ft. (18018); Piute Pass, 12000 ft. (18074); Mono Pass, 12000 ft. (18107).

Intermontane Plateaus. COLORADO PLATEAUS PROVINCE: LA SAL MOUNTAINS—Mt. Mellenthin, 12890 ft. (16918, 16929). SAN FRANCISCO MOUNTAINS—Agassiz Peak, 12340 ft. (12719, 12722, 12723, 12727, 17914, 17922, 17923).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: Bow RANGE—Eagle Mt., 2900 m. (*Lamb* 6451); Quartz Hill, 2650 m. (*Lamb* 6465). LEWIS RANGE—Appekunny Basin, 6000 ft. (5604, 5614); Altyn Peak, 7500 ft. (5658, 5677); Swiftcurrent Pass, 7000 ft. (6139, 6171); Appekunny Mt., 8500 ft. (6248, 6264, 6300a, 6303); Goat Mt., 8800 ft. (6530, 6543); Reynolds Mt., 7700 ft. (7777); Swiftcurrent Mt., 8300 ft. (7898); Dawson Pass, 7500-8000 ft. (8632, 8681); Scenic Point, 7600 ft. (8798). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18789). PIONEER MOUNTAINS—Hyndman Pass, 10600-11100 ft. (16647). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9733, 9798). TETON RANGE—Summit Divide, Indian Paintbrush Trail, 10600 ft. (9172); Pinnacle above Surprise Lake, 9900 ft. (9235, 9243); Static Peak, 11294 ft. (9311, 9359). WIND RIVER RANGE—Mt. Lester, 11700 ft. (19064, 19068). BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19156). UINTA MOUNTAINS—Robert's Pass, Chain Lakes (S-10294); Murdock Mt., 11000 ft. (16715); Bald Mt., 11947 ft. (16760); Leidy Peak, 12013 ft. (17191, 17258); Marsh Peak, 12219 ft. (17265, 17269); Bald Mt., 11300 ft. (16766). WASATCH MOUNTAINS—Mt. Baldy, 11049 ft. (16834, 16838). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18891, 18896, 18929). FRONT RANGE—Trail Ridge, 11800-12000 ft. (11185, 11201, 11229, 11245, 11254, S-1416); Niwot Ridge, Apache Peak, 11500 ft. (S-834); Mt. Evans, 12000-14260 ft. (11042, 11089, 11112, S-282, S-2895); Pikes Peak, 13300-14100 ft. (11959, S-5688, S-5696); above Fool Creek, 11500 ft. (S-1676). PARK RANGE—Hoosier Ridge, 13000 ft. (19035); Wheeler Lake, 12300 ft. (S-2775). SAWATCH MOUNTAINS—Mt. Massive, 12750-14418 ft. (11869, 11905, 11909a, 11917a, 11925); Lake Pass, 12225 ft. (11787a, 11813a, 11818); Cumberland Pass, 12000-12400 ft. (11480a, 11489a, 11500, 11525a, 11530); Independence Pass, 10100 ft. (11565); Cottonwood Pass, 12700 ft. (11643); two miles southeast of Monarch Pass, 12000 ft. (S-10296). ELK MOUNTAINS—East Maroon Pass, 11850 ft. (10668, 10675, 10691, 10696, 10709); Mt. Belleview, 12500 ft. (10507, 10527); Gothic Mt., 12646 ft. (10366, 10377, 10382, 10386, 10389, 10407, 10432); Virginia Ridge, 12300-12400 ft. (10570a, 10599a); White Rock Mt., 13000 ft. (10986); Conundrum Pass, 12700 ft. (S-5984). SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16955, 16964, 17026, 17040, 17041); ridge between Engineer & Gravel Mtns., 13000-13200 ft. (17056, 17060, 17076, 17099, 17112); above Slumgullion Pass, 11600 ft. (S-210). SAN MIGUEL MOUNTAINS—Black Face, 12200 ft. (17137, 17152, 17154, 17170, 17184, 17187a). SANGRE DE CRISTO RANGE—West Spanish Peak, 13600 ft. (12036, 12063a, 12068, 12072, 12075a, 12076); Trinchera Peak, 13546 ft. (12174a, 12176, 12180); Wheeler Peak, 13100 ft. (12247, 12248, 12300); Gold Hill, 12660 ft. (12341, 12346).

Alpine collections of *P. stenophylla* have been reported from Pikes Peak in Colorado (Whitfield, 1933, sub *P. conspersa*), Horse Shoe Mt. in Colorado (Willey, 1874, sub *P. kamtschadalis* var. *americana*), Baldy Peak in New Mexico (Bouly de Lesdain, 1932, sub *P. molliuscula*) and the Uinta Range in Utah (Hayward, 1952).

This species is a member of the *P. conspersa*-group, which is extremely variable and consequently beset with numerous taxonomic problems. The material cited above is itself quite variable as to substrate and gross appearance. Some specimens are saxicolous and closely appressed to the rock while others are saxicolous and loosely attached to the rock. Many specimens grow on the soil and may form loose balls. In the latter two types the margins are involute. All three types of thalli may be found in different parts of the same individual where it grows partly on rock and partly on soil. The one constant feature is the absence of isidia on all alpine material. I am convinced after much field work that all the alpine specimens represent one species, *P. stenophylla*.

Section Parmelia [= Hypotrachyna (Wain.) Zahlbr.]

14. PARMELIA SAXATILIS (L.) Ach. Meth. Lich. 204. 1803. *Lichen saxatilis* L. Sp. Pl. 1142. 1753. (*Map* 43)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17537); Moose Lake Trail, 6200-6500 ft. (17592, 17598). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18620). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7100-7400 ft. (17352).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Little Mt. Richardson, 2700 m. (*Lamb* 6335); Twin Cairns Mt., 2700 m. (*Lamb* 6499). LEWIS RANGE—Swiftcurrent Pass, 7000 ft. (6160); Piegan Pass, 8000 ft. (7994). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12700 ft. (S-5637).

This is a common species in the forested area below timberline but it is only of sporadic occurrence in alpine areas.

15. PARMELIA SULCATA Tayl. in Mack. Fl. Hibern. 2: 145. 1836.

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Twin Cairns Mt., 2700 m. (*Lamb* 6499).

This is a common species in the forested area below timberline but has been found only once above timberline.

16. PARMELIA OMPHALODES (L.) Ach. Meth. Lich. 204. 1803. *Lichen omphalodes* L. Sp. Pl. 1143. 1753.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7300 ft. (189).

CETRARIA

1. Thallus foliose 2
1. Thallus fruticose to subfruticose 5
2. Thallus yellow or greenish-yellow 3
2. Thallus brown or dark olivaceous-green 4
3. Sorediate ..... *C. pinastri*

3. Not sorediate ..... *C. tilesii*
   4. Conidia ellipsoidal; thallus pale below; medulla KOH− & PD− ..... *C. fahlunensis*
   4. Conidia with incrassated ends; thallus dark below and more appressed; medulla KOH+ (yellow) and PD+ (red) .... *C. hepatizon*
5. Thallus brown or dark olivaceous-green; margins ciliose-spinulose; bases red (*C. islandica*) 6
5. Thallus yellow or greenish-yellow 7
   6. Pseudocyphellae laminal; medulla PD+ (orange to red) ..... *C. islandica* subsp. *islandica*
   6. Pseudocyphellae marginal; medulla PD− .... *C. islandica* subsp. *crispa*
7. Laciniae ± tubular; surface smooth; bases dark red to purple ..... *C. cucullata*
7. Laciniae ± flattened; surface reticulate with concave areas; bases yellow to orange ..... *C. nivalis*

1. Cetraria pinastri (Scop.) S. Gray, Natur. Arrang. Brit. Pl. 1: 432. 1821. *Lichen pinastri* Scop. Fl. Carniol. ed. 2. 2: 382. 1772.

Pacific Mountain System. Cascade-Sierra Mountains Province: Northern Cascade Mountains—Windy Peak, 8345 ft. (18658, 18697).

This species is usually found on bark in the forested areas, but the above collections were found on soil.

2. Cetraria tilesii Ach. Syn. Lich. 228. 1814.

Rocky Mountain System. Northern Rocky Mountains Province: Bow Range—Quartz Hill, 2650 m. (*Lamb* 6465); Mt. Rundle, 8300 ft. (6595); near Victoria Glacier (6903); Sulphur Mt., 2500 m. (*Lamb* 6188); Little Mt. Richardson, 2865 m. (*Lamb* 6318); Redoubt Mt., 2650 m. (*Lamb* 6434). Lewis Range—Goat Mt., 8800 ft. (6522, 6527, 6532); Siyeh Pass, 8200 ft. (8961, 9006). Middle Rocky Mountains Province: Beartooth Range—Beartooth Pass, 11000 ft. (9645, 9688). Uinta Mountains—Marsh Peak, 12219 ft. (17299). Southern Rocky Mountains Province: Front Range—Upper Green Lakes north of Kiowa Peak (S-1441); Trail Ridge, 12000 ft. (11212); Mt. Evans, 12000-14260 ft. (S-277, S-758, S-2916, S-3395, S-5617, 11083, 11094, 11106, 11107, 11110, 11111); Pikes Peak, 13300 ft. (11965, S-5698). Park Range—Hoosier Ridge, 13000 ft. (18962); Loveland Pass, 12500 ft. (S-2698). Sawatch Mountains—Independence Pass, 12100 ft. (11556); Lake Pass, 12225 ft. (11796); Mt. Massive, 13000 ft. (11933). Elk Mountains—North Italian Peak, 11000-13300 ft. (S-5871). Sangre de Cristo Range—Trinchera Peak, 13500 ft. (12153).

Alpine records of this species have been published from Pikes Peak in Colorado (Whitfield, 1933, sub *C. juniperina*) and other localities in Colorado (Tuckerman, 1866b, sub *C. juniperina* var. *terrestris*, and Weber & Shushan, 1955).

3. Cetraria fahlunensis (L.) Schaer. Lich. Helv. Spicil. 4-5: 255. 1833. *Lichen fahlunensis* L. Sp. Pl. 1143. 1753. (*Map* 8)

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18601, 18626). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7400 ft. (183b, 17379, 17393, 17408).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: Bow RANGE—Redoubt Mt., 2830 m. (*Lamb* 6428, 6429); Silvertip Mt., 2850 m. (*Lamb* 6356). LEWIS RANGE—Piegan Pass, 8000 ft. (8003, 8035); Dawson Pass, 7500-8000 ft. (8620, 8622); Appekunny Basin, 6000 ft. (5602, 5622a); Appekunny Mt., 8500 ft. (6276, 6282). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12700-12800 ft. (S-1595, S-5616); Pikes Peak, 14100 ft. (S-5672, S-5393).

Weber & Shushan (1955, sub *C. commixta*) have reported alpine collections of *C. fahlunensis* from Mt. Evans and Pikes Peak in Colorado.

This species is frequently referred to in the recent literature as *C. commixta* (Nyl.) Th. Fr. Wainio (1888) has shown, however, that the specimens of *Lichen fahlunensis* in the Linnean herbarium are identical to *C. commixta*. The fact that *C. hepatizon* was frequently called *C. fahlunensis* seems insufficient reason for disregarding the long accepted Linnean species.

4. CETRARIA HEPATIZON (Ach.) Wain. Természetr. Füzetek 22: 278. 1899. *Lichen hepatizon* Ach. Lich. Suec. Prodrom. 110. 1798. (*Map* 9)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17578, 17614, 17619). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Tiffany Mt., 8275 ft. (18751, 18752); Windy Peak, 8345 ft. (18684); Pugh Mt., 7150 ft. (18513, 18515). MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7400 ft. (17452, 17479).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Appekunny Basin, 6000 ft. (5606); Reynolds Mt., 7700 ft. (7789).

5. CETRARIA CUCULLATA (Bell.) Ach. Meth. Lich. 293. 1803. *Lichen cucullatus* Bell. Oss. Bot. 54. 1788. (*Map* 7)

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17487, 17500, 17535). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18643, 18648, 18654, 18696); Slate Peak, 7488 ft. (18580).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: Bow RANGE—Mt. St. Piran, 2850 m. (*Lamb* 6308); Sulphur Mt., 2500 m. (*Lamb* 6189); Little Mt. Richardson, 2700 m. (*Lamb* 6320). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 11500-13100 ft. (11101, S-209, S-209a, S-3754); Trail Ridge, 12000 ft. (11197). PARK RANGE—Hoosier Ridge, 12500-13000 ft. (18991, 19021, S-242a). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11521); Mt. Massive, 12750 ft. (11893). SANGRE DE CRISTO RANGE—Trinchera Peak, 13500 ft. (12164, 12172); Wheeler Peak, 13100 ft. (12286).

Alpine records of *C. cucullata* have been published from the Canadian Rocky Mountains (Fink, 1907), Baldy Peak in New Mexico (Bouly de Lesdain, 1932) and various localities in Colorado (Weber & Shushan, 1955).

There is some variation in the color of the thallus; either the green or the yellow may predominate. Apothecia were found only once, in collection no. 17487. *Cetraria cucullata* is rarer than *C. nivalis* in the alpine areas as well as in the arctic areas.

6. CETRARIA NIVALIS (L.) Ach. Meth. Lich. 294. 1803. *Lichen nivalis* L. Sp. Pl. 1145. 1753.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17505, 17561, 17571); Moose Lake Trail, 6200-6500 ft. (17585). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18645, 18655, 18698); Slate Peak, 7488 ft. (18561, 18612, 18638).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Mt. St. Piran, 2895 m. (*Lamb* 6306); Mt. Rundle, 8300 ft. (6603); Sulphur Mt., 2500 m. (*Lamb* 6184). LEWIS RANGE—Swiftcurrent Pass, 7000 ft. (6144, 6155); Goat Mt., 8800 ft. (6533); Reynolds Mt., 7700 ft. (7757); Piegan Pass, 8000 ft. (8076); Garden Wall above Grinnell Glacier, 8000 ft. (8477); Dawson Pass, 7500-8000 ft. (8628); Scenic Point, 7600 ft. (8806); Siyeh Pass, 8000 ft. (S-3153). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9578, 9603). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—among alpine rocks (S-1461). FRONT RANGE—Trail Ridge, 12000 ft. (S-1419, 11219); Flattop Mt., 12100 ft. (S-4016); Mt. Evans, 12700-13100 ft. (11113, 11131, S-1408); Pikes Peak, 13300 ft. (11972, S-5699). PARK RANGE—Grays Peak, 13500 ft. (S-1922); Hoosier Ridge, 12500-13000 ft. (19008, S-242). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11482); Cottonwood Pass, 12700 ft. (11655); Independence Pass, 12100 ft. (11563); Lake Pass, 12225 ft. (11774, 11799); Mt. Massive, 12750-14418 ft. (11852, 11901); two miles southeast of Monarch Pass, 12000 ft. (S-10293). ELK MOUNTAINS—East Maroon Pass, 12000 ft. (S-1986); Conundrum Pass, 12700 ft. (S-5817). WEST ELK MOUNTAINS—Ohio Peak, Anthracite Range, 9500-12000 ft. (S-6300). SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16946); ridge between Engineer and Gravel Mtns., 13000 ft. (17113). SANGRE DE CRISTO RANGE—Trinchera Peak, 13500 ft. (12164, 12199); Wheeler Peak, 13100 ft. (12277); Gold Hill, 12660 ft. (12379).

Alpine records of this species have been published from the Canadian Rocky Mountains (Fink, 1907, 1919), Baldy Peak in New Mexico (Bouly de Lesdain, 1932) and from various localities in Colorado (Weber & Shushan, 1955).

Apothecia were not found in any of the alpine material.

7. CETRARIA ISLANDICA (L.) Ach. Meth. Lich. 293. 1803. *Lichen islandicus* L. Sp. Pl. 1145. 1753.

Cetraria islandica sens. lat. has long attracted the attention of American collectors and a number of notes have appeared concerning the occurrence of this "arctic relic" below the line of maximum

glaciation. Until recently, however, American workers have failed to distinguish between *C. islandica sens. strict.* and *C. crispa* (Ach.) Nyl., long recognized as distinct species in Europe. Although European material is easily separated into these two species it is not always possible to designate material from other areas as one or the other. To illustrate this it is helpful to trace the history of the diagnostic characters used to distinguish the two species. Originally *C. islandica sens. strict.* included all those specimens with plane laciniae and *C. crispa* those with canaliculate-connivent laciniae. Later, Wainio pointed out that *C. islandica* was best distinguished by having both laminal and marginal pseudocyphellae while *C. crispa* had only marginal pseudocyphellae. For a long while this was taken to be the most critical character. The variability in the pseudocyphellae of arctic specimens, however, led to the search for an additional aid in identification and the introduction of paraphenylenediamine into the lichenologists' list of reagents showed that European *C. islandica* was PD+ (cinnabar) while European *C. crispa* was PD—. As a result, extra-European specimens were sorted out on the basis of this chemical test. In the arctic, plants that formerly were called *C. crispa* because of canaliculate-connivent laciniae and the absence of laminal pseudocyphellae were found to be either PD+ or PD— and, consequently, were now called either *C. islandica* or *C. crispa.*

Asahina (*in* Sato, 1938) noted that in Japanese material specimens which morphologically corresponded to *C. crispa* were PD+ and these were described as *C. crispa* var. *japonica.* On the other hand, specimens which morphologically corresponded to *C. islandica* were PD— and these were described as *Cetraria islandica* var. *orientalis.* That is, the chemical reactions were reversed from what they were in Europe! What seemed to be a simple solution in Europe was not workable elsewhere.

Furthermore, the type from Pitlekai (Siberia) described by Wainio as *C. islandica* var. *maculata* is in many respects intermediate between *C. islandica* and *C. crispa, i.e.,* has the laminal pseudocyphellae and the PD+ reaction of *C. islandica* but is canaliculate-connivent, and the apothecia are ± ciliate as in *C. crispa.* This is the taxon found in the high mountains of New England (U. S. A.).[14] That it can only be assigned quite arbitrarily as a variety under either *C. islandica* or *C. crispa* has already been indicated by Degelius (1940).

In eastern North America, there is an undescribed type which

[14] I have not seen typical *C. islandica sens. strict.* from eastern North America.

is intermittently plane and canaliculate-connivent with laminal pseudocyphellae present in expanded portions. The apothecia are dentate-ciliate as in *C. crispa,* and the medulla is PD—. This taxon is frequently collected around the Great Lakes and the Atlantic seaboard and also merits nomenclatural recognition.

Removed from the *C. islandica*-group are *C. islandica* mod. *arborialis* (= *C. subalpina* Imsh.) and *C. islandica* var. *robustum* D. Branth *in* Macoun (*nomen nudum*). The former is more closely related to *C. richardsonii* while the latter is the same as *C. hiascens* var. *macrophylla* Merrill and probably *C. delisei* var. *dilatata* Wain. Most reports of *C. islandica* var. *platyna* from North America (*e.g.,* Howe, 1915) also refer to this form of *C. delisei.*

After a study of specimens representing all of these types, I have come to the conclusion that *C. islandica* is a circumboreal species which was isolated in various parts of the world during the glacial periods. In the interglacials different biotypes have developed in the different relic areas and some of these biotypes have migrated more extensively than others with the result of overlapping distributions at the present time. I would, therefore, recognize several subspecies rather than several species. The arguments for this philosophy are admirably presented by Hultén (1937). The recognition of two species, *C. islandica* and *C. crispa,* in one part of the world but not in another, is taxonomically unjustifiable.[15]

Subsp. ISLANDICA.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17542). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18653, 18701); Slate Peak, 7488 ft. (18594). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7100-7400 ft. (17386).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Silvertip Mt., 2600 m. (*Lamb* 6436). LEWIS RANGE—Logan Pass area, 7700 ft. (S-3143). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9577). BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19141, 19163). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Trail Ridge, 12000 ft. (11221, 11236); Mt. Evans, 11500-12700 ft. (S-1409, S-3762); above Fool Creek, 11500 ft. (S-1683); Upper Green Lakes north of Kiowa Peak, 11500 ft. (S-1443a). PARK RANGE—Wheeler Lake, 12300 ft. (S-2723); Hoosier Ridge, 13000 ft. (19056). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11486); Inde-

[15] In a similar situation in *Cladonia, C. coccifera sens. strict.* and *C. pleurota,* Dahl (1950, p. 24) wrote, "In my opinion we have the peculiar situation that in one area (Europe) we have two good species, but the same systematic units in other districts (Japan, Greenland) cannot be considered more than varieties."

pendence Pass, 12100 ft. (11585). San Juan Mountains—ridge between Engineer and Gravel Mts., 13000 ft. (17114, 17120).

Alpine records of *C. islandica* subsp. *islandica* have been published from Baldy and Lake Peaks in New Mexico (Bouly de Lesdain, 1932) and from various localities in Colorado (Weber & Shushan, 1955).

Subsp. crispa (Ach.) Cromb. Grevillea 12: 73. 1884. *Cetraria islandica* β *crispa* Ach. Lich. Univ. 513. 1810.

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17565). Cascade-Sierra Mountains Province: Northern Cascade Mountains—Windy Peak, 8345 ft. (18644, 18689); Tiffany Mt. 8275 ft. (18745); Slate Peak, 7488 ft. (18594a); Pugh Mt., 7150 ft. (18505). Middle Cascade Mountains—Burroughs Mt., 6500-7400 ft. (181, 17403); Mt. Fremont, 7100-7200 ft. (17480).

Intermontane Plateaus. Colorado Plateaus Province: San Francisco Mountains—Agassiz Peak, 12340 ft. (12717, 17869).

Rocky Mountain System. Northern Rocky Mountains Province: Bow Range—Mt. St. Piran, 2895 m. (*Lamb* 6304); Silvertip Mt., 2500 m. (*Lamb* 6442); Little Mt. Richardson, 2865 m. (*Lamb* 6321); near Victoria Glacier (6930); Mt. Rundle, 8300 ft. (6606). Lewis Range—Appekunny Mt., 8500 ft. (6280); Reynolds Mt., 7700 ft. (7770); Swiftcurrent Mt., 8300 ft. (7851); Scenic Point, 7600 ft. (8825); Dawson Pass, 7500-8000 ft. (8642). Middle Rocky Mountains Province: Big Horn Mountains—Loaf Mt., 11000 ft. (19141). Southern Rocky Mountains Province: Medicine Bow Mountains—Medicine Bow Peak, 12000 ft. (18890, 18906, 18919). Front Range—Trail Ridge, 12000 ft. (11198, 11222, S-1421); Mt. Evans, 11500-13100 ft. (11118, S-2917, S-2924, S-3763); Pikes Peak, 13300 ft. (11951, S-5695); Upper Green Lakes north of Kiowa Peak, 11500 ft. (S-1443); above Fool Creek, 11500 ft. (S-1683a). Park Range—Wheeler Lake, 12300 ft. (S-2852); Grays Peak, 13700 ft. (S-1925); Hoosier Ridge, 13000 ft. (18989). Sawatch Mountains—Cumberland Pass, 12000-12400 ft. (11495); Independence Pass, 12100 ft. (11546); Cottonwood Pass, 12250 ft. (11675); Lake Pass, 12225 ft. (11793); Mt. Massive, 12750 ft. (11906). Elk Mountains—Virginia Basin, 12000 ft. (10614); Virginia Ridge, 12300-12400 ft. (10564, 10596); East Maroon Pass, 11850 ft. (10715); White Rock Mt., 12800 ft. (10971); Queen's Basin, 12000 ft. (S-1984); Conundrum Pass, 12700 ft. (S-5986). San Juan Mountains—Blue Lake Pass, 12500 ft. (16960); ridge between Engineer and Gravel Mtns., 13000 ft. (17114, 17120). San Miguel Mountains—Black Face, 12200 ft. (17165). Sangre de Cristo Range—Trinchera Peak, 13500 ft. (12159); Wheeler Peak 13100 ft. (12253, 12284).

Weber & Shushan (1955) have reported *C. islandica* subsp. *crispa* from alpine areas in Colorado.

Dactylina

1. Thallus large (2-6 cm.), turgid, inflated, ± unbranched.....*D. arctica*
1. Thallus small (1-2 [3.5] cm.), much branched..... 2
   2. Epruinose, pycnidia common.....*D. madreporiformis*
   2. Pruina white or ± violet; pycnidia rare; thallus fistulous, muricate branched.....*D. ramulosa*

1. Dactylina arctica (Richards.) Nyl. Mém. Soc. Imp. Sci.

Nat. Cherbourg 5: 99. 1857. *Dufourea arctica* Richards. Narrat. Jour. Polar Sea 775, *pl.* 31, *f.* 1-5. 1823.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18648a, 18703). MIDDLE CASCADE MOUNTAINS—Sunset Lodge, Mt. Rainier National Park (private herb. John W. Thomson).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: Bow RANGE—Silvertip Mt., 2850 m. (*Lamb* 6439); Mt. St. Piran, 2850 m. (*Laml* 6303, 6309).

I have searched for additional material from Mt. Rainier National Park but without success. It must be rare in that region. At Windy Peak, however, the species is rather common near the summit. Alpine records of *D. arctica* from the Canadian Rocky Mountains have been published by Fink (1907, 1919), Macoun (1902) and Lynge (1933).

Hooker is usually cited as the author of this species. An examination of the original publication however, shows that the "Botanical Appendix" was authored by John Richardson, and he credits Dr. Hooker with the examination of the lichens. The species *D. arctica*, however, is not credited to Hooker in the text, although *Cetraria richardsonii* is. One cannot, therefore, cite Hooker as the author of *D. arctica*.

2. DACTYLINA MADREPORIFORMIS (Ach.) Tuck. Proc. Amer. Acad. 5: 398. 1862. *Dufourea madreporiformis* Ach. Lich. Univ. 525. 1810.

Rocky Mountain System. MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9725, 9726, 9631, 9764). UINTA MOUNTAINS—Leidy Peak, 12013 ft. (17243, 17252); Marsh Peak, 12219 ft. (17286). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Trail Ridge, 12000 ft. (11230, 11252, S-1420); Mt. Alice, 12700 ft. (S-4024); Mt. Evans, 11500-14260 ft. (11060, 11081, 11116, 11132, S-283, S-283a, S-3761, S-5619); Pikes Peak, 13300 ft. (11954, S-5694); above Fool Creek, 11500 ft. (S-1671). PARK RANGE—Grays Peak, 13500 ft. (S-1921); North Star Mt., 12300-12500 ft. (S-238, S-2851); Hoosier Ridge, 13000 ft. (19023). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11510); Independence Pass, 12100-12900 ft. (11571, 11593); Cottonwood Pass, 12700 ft. (11632); Lake Pass, 12225 ft. (11822); Mt. Massive, 12750 ft. (11920). ELK MOUNTAINS—Virginia Ridge, 12000-12400 ft. (S-6292, 10575, 10600, 10602); East Maroon Pass, 11850 ft. (10686); White Rock Mt., 13000 ft. (11026); North Italian Mt., 13200 ft. (S-399); Conundrum Pass, 12300 ft. (S-5812). SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16940, 16944); ridge between Engineer and Gravel Mtns., 13000-13200 ft. (17049, 17105, 17114a). SAN MIGUEL MOUNTAINS—Black Face, 12200 ft. (17147). SANGRE DE CRISTO RANGE—Trinchera Peak, 13500 ft. (12186, 12193); Gold Hill, 12660 ft. (12373, 12394); Wheeler Peak, 13100 ft. (12307).

Alpine records of *Dactylina madreporiformis* have been published from the Canadian Rocky Mountains (Fink, 1907, 1919; Macoun, 1908), the Uinta Mountains in Utah (Lynge, 1933), Baldy Peak in New Mexico (Bouly de Lesdain, 1932) and various localities in Colorado (Tuckerman, 1862; Willey,

1874; Lynge, 1933; Weber & Shushan, 1955). The records from the Canadian Rocky Mountains, however, represent *D. ramulosa*.

The basionym of this species is frequently listed as *Lichen madreporiformis* Wulf. *in* Jacq. but the description and illustration in Jacquin (Coll. Bot. 3: 105, *pl.* 3, *f.* 2. 1789) refers to a species of *Cladonia*. Acharius (1810) cited L. *madreporiformis* Jacq. as a questionable synonym with the note that the specimen does not agree with the figure. It is better, therefore, to accept Acharius as the author of the basionym.

There is a peculiar compressed form found rather frequently in our alpine areas. This form has been mentioned by Weber and Shushan (1955). In some of my collections the expanded laciniae even have rhizinae on the lower surface. The thallus is then very prostrate with a definite radiating pattern and may be confused with *Parmelia separata, Cetraria tilesii* or *Cetraria nivalis*. Collection no. 11593 is an example of this form. I believe that this is the same variation described by Wainio as var. *irregularis* [in Bot. Tidsskrift Kbhavn. 26: 241-250. 1905 (publ. 1904)].

One collection was found with terminal mounds of white soredia. This merits nomenclatural recognition as a form:

Dactylina madreporiformis f. **sorediata** f. nov. Soraliis albis usque ad 1 mm. latis a typo discrepat.

Type: Collected by H. A. Imshaug, no. 11510, 26 July 1952, at Cumberland Pass, near town of Tincup, Sawatch Range, Colorado. Holotype in MICH; isotype in MSC.

3. Dactylina ramulosa (Hook.) Tuck. Proc. Amer. Acad. 5: 397. 1862. *Dufourea ramulosa* Hook. Append. Parry's Sec. Voyage 4: 424. 1825.

Rocky Mountain System. Northern Rocky Mountains Province: Bow Range—Mt. Rundle, 8300 ft. (6591, 6599); Silvertip Mt., 2850 m. (*Lamb* 6441); Mt. St. Piran, 2850 m. (*Lamb* 6301); Sulphur Mt., 2500 m. (*Lamb* 6187). Lewis Range—Swiftcurrent Mt., 8300 ft. (7842, 7880, 7892). Flint Creek Range—Mt. Powell, 10213 ft. (18771, 18772). Middle Rocky Mountains Province: Beartooth Range—Beartooth Pass, 11000 ft. (9567, 9568).

Alpine records of *D. ramulosa* have been published from the Canadian Rocky Mountains by Macoun (1902), Lynge (1933) and Fink (1907, 1919, sub *D. madreporiformis*). The above cited collections represent, however, the first record of this species in the United States. Inasmuch as *D. madreporiformis* is cited from northern Wyoming for the first time, these two species of *Dactylina* are now known to have overlapping ranges.

Lynge (1933) reported and mapped a Macoun collection of *D. ramulosa* from the Moose Mountains in Saskatchewan. This seems, however, very improbable, especially since Macoun (1902) did not cite this locality.

CORNICULARIA

1. Terricolous; thallus erect, much branched with spinulose tips; apothecia rare.....*C. aculeata*
1. Saxicolous; thallus prostrate, simple or sparingly branched with radiate pattern, tips not spinulose; apothecia abundant.....*C. normoerica*

1. CORNICULARIA ACULEATA (Schreb.) Ach. Meth. Lich. 302. 1803. *Lichen aculeatus* Schreb. Spicil. Fl. Lipsiens. 125. 1771.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17523, 17572). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18688); Tiffany Mt., 8275 ft. (18729); Slate Peak, 7488 ft. (18617, 18634, 18636); Pugh Mt., 7150 ft. (18464, 18466). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7100-7400 ft. (17394); Willis Wall, Mt. Rainier, 7500 ft. (S-9948).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: Bow RANGE—near Victoria Glacier (6895); Mt. Rundle, 8300 ft. (6596); Mt. St. Piran, 2895 m. (*Lamb* 6305); Quartz Hill, 2650 m. (*Lamb* 6465, 6495). LEWIS RANGE—Wynn Mt., 7600 ft. (S-3156); Appekunny Basin, 6000 ft. (5617); Altyn Peak, 7500 ft. (5655, 5685, 5700); Swiftcurrent Pass, 7000 ft. (6115, 6230, 6234a); Appekunny Mt., 8500 ft. (6241); Goat Mt., 8800 ft. (6490); Reynolds Mt., 7700 ft. (7807); Swiftcurrent Mt., 8300 ft. (7856, 7885); Piegan Pass, 8000 ft. (8088); Garden Wall above Grinnell Glacier, 8000 ft. (8422, 8456); Dawson Pass, 7500-8000 ft. (8674); Scenic Point, 7600 ft. (8861, 8864); Siyeh Pass, 8200 ft. (9024). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9574, 9786). TETON RANGE—Summit Divide, Indian Paintbrush Trail, 10600 ft. (9134, 9170). WIND RIVER RANGE—Mt. Lester, 11700 ft. (19084). BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19171). UINTA MOUNTAINS—Marsh Peak, 12219 ft. (17285). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18920). FRONT RANGE—Trail Ridge, 12000 ft. (11220, S-1418); Mt. Evans, 12000-13100 ft. (11122, S-500, S-1614, S-2894); Pikes Peak, 13300-14100 ft. (S-5683, S-5700, 11938); Green Lakes Valley, north of Kiowa Peak, 11500 ft. (S-1446, S-1456); Longs Peak, 11050 ft. (S-379). PARK RANGE—North Star Mt., 12300 ft. (S-2853); Hoosier Ridge, 13000 ft. (19017). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11505); Independence Pass, 12100 ft. (11540); Cottonwood Pass, 12700 ft. (11630); Mt. Massive, 12750-14418 ft. (11862, 11921). ELK MOUNTAINS—Virginia Basin, 12000 ft. (10624); Virginia Ridge, 12000-12400 ft. (S-6291, 10602a); East Maroon Pass, 11850 ft. (10716); White Rock Mt., 12800 ft. (10975); Conundrum Pass, 12000 ft. (S-5811). SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16963); ridge between Engineer and Gravel Mtns., 13000 ft. (17117). SAN MIGUEL MOUNTAINS—Black Face, 12200 ft. (17173). SANGRE DE CRISTO RANGE—West Spanish Peak, 13600 ft. (12086); Trinchera Peak, 13546 ft. (12164a); Gold Hill, 12660 ft. (12363); Wheeler Peak, 13100 ft. (12306).

Alpine records of *C. aculeata* have been reported from the Lake Louise area in the Canadian Rocky Mountains (Fink, 1907), Baldy Peak in New Mexico (Bouly de Lesdain, 1932) and from various localities in Colorado (Weber & Shushan, 1955, sub *C. tenuissima*).

Several authors have used the name *C. tenuissima* for this species. This is based, however, on *Lichen islandicus* var. *tenuissimus* L. not L. *tenuissimus* L. as they imagined. Oeder (1770) also wrote *L. islandicus tenuissimus* instead of *L. tenuissimus* as cited in Zahlbruckner (1930). *Cornicularia aculeata,* therefore, has priority on the specific level.

This species is rather variable with some specimens having short internodes and almost no spines, while other specimens have long internodes and many spines. Although usually erect, some material appears more or less prostrate. The medulla was usually more or less solid in the alpine material examined.

One collection (11665) from above Cottonwood Pass, 12700 ft., in the Sawatch Mountains, was sorediate and can be referred to var. SOREDIATA (DR.) Zahlbr. (*C. racemosa* Lynge).

2. CORNICULARIA NORMOERICA (Gunn.) DR. Ark. Bot. 20A (11): 39. 1926. *Lichen normoericus* Gunn. Fl. Norveg. 2: 123, *pl.* 2, *f.* 1. 1776.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17608). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18556, 18641); Pugh Mt., 7150 ft. (18488). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7400 ft. (185a, 17411, 17417).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Reynolds Mt., 7700 ft. (7795).

Alpine records of *C. normoerica* have been reported from the Cascade Mountains of Washington (Howard, 1950) and from the alpine summit of Mt. Hood in Oregon (Tuckerman, 1882).

USNEACEAE

EVERNIA

1. EVERNIA DIVARICATA (L.) Ach. Lich. Univ. 441. 1810. *Lichen divaricatus* L. Syst. Veg. ed. 12. 713. 1768. (*Map 29*)

Rocky Mountain System. MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9587, 9602). SOUTHERN ROCKY MOUNTAINS PROVINCE: PARK RANGE—Hoosier Ridge, 13000 ft. (19034). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11517); Independence Pass, 12100-12900 ft. (11541, 11606); Cottonwood Pass, 12700 ft. (11627); Mt. Massive, 12750 ft. (11883); two miles southeast of Monarch Pass, 12000 ft. (S-10297). SANGRE DE CRISTO RANGE—Gold Hill, 12660 ft. (12383).

Although *Evernia divaricata* is usually corticolous at lower elevations in the Rocky Mountains, there seems little doubt but that it can grow above timberline over rock or on the ground between rocks in the tundra. Frey (1952) has also reported it above timberline in the Alps at elevations up to 2600 meters. It is possible

that *Evernia perfragilis* Llano is also a tundra form of this usually corticolous species. There is a similar situation in *E. mesomorpha* which is also usually a corticolous species but which has been found in rock crevices in the arctic (Thomson, 1953; Lynge & Scholander, 1932).

Letharia

1. Letharia vulpina (L.) Hue, Nouv. Arch. Muséum IV. 1: 57. 1899. *Lichen vulpinus* L. Sp. Pl. 1155. 1753.

Pacific Mountain System. Cascade-Sierra Mountains Province: Middle Cascade Mountains—Burroughs Mt., 7300 ft. (*273*).

Rocky Mountain System. Northern Rocky Mountains Province: Lewis Range—Altyn Peak, 7500 ft. (5671).

This is a corticolous species which is abundant in the rather open *Pinus ponderosa* and *Pseudotsuga taxifolia* forests. It is less common in the spruce-fir forest of higher elevations and is only rarely found saxicolous above timberline.

Alectoria

1. Thallus brown or black, at least in part 2
1. Thallus ochraceous or stramineous ..... *A. sarmentosa*
2. Not pale towards the base 3
2. Paler towards the base ..... *A. nigricans*
3. Not sorediate; saxicolous 4
3. Sorediate; not saxicolous ..... *A. jubata*
4. Filaments terete, internodes long ..... *A. pubescens*
4. Filaments frequently ± flattened or torulose; internodes short; frequently nitid; occasionally regenerating ..... *A. minuscula*

Subgenus Bryopogon (Link) Th. Fr.
Section Subparmelia Degel.

1. Alectoria pubescens (L.) Howe, Class. Famil. Usneac. 23. 1912. *Lichen pubescens* L. Sp. Pl. 1155. 1753.

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17536, 17567); Moose Lake Trail, 6200-6500 ft. (17599a). Cascade-Sierra Mountains Province: Northern Cascade Mountains—Tiffany Mt., 8275 ft. (18736); Slate Peak, 7488 ft. (18568, 18607, 18608, 18629a, 18639); Pugh Mt., 7150 ft. (18491, 18504, 18507, 18516). Middle Cascade Mountains—Anvil Rock, Mt. Rainier, 9600 ft. (2079, 2088, 2094); Burroughs Mt., 7100-7400 ft. (17367); Mt. Fremont, 7100-7200 ft. (17426a, 17435a); ridge between North & Middle Sister, 9000 ft. (18357, 18359, 18366).

Intermontane Plateaus. Columbia Plateaus Province: Wallowa Mountains—Eagle Cap, 9675 ft. (18830, 18846).

Rocky Mountain System. Northern Rocky Mountains Province: Bow Range—Mt. St. Piran, 2895 m. (*Lamb* 6400, 6413); Twin Cairns Mt., 2800 m. (*Lamb* 6527); Little Mt. Richardson, 2865 m. (*Lamb* 6334). Lewis

RANGE—Appekunny Basin, 6000 ft. (5648); Goat Mt., 8800 ft. (6542); Reynolds Mt., 7700 ft. (7767); Piegan Pass, 8000 ft. (8026); Scenic Point, 7600 ft. (8876). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18785). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9607, 9655, 9674, 9698, 9699, 9703, 9737). BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (19116, 19143, 19154, 19168). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18918). FRONT RANGE—Mt. Evans, 12700-12800 ft. (S-1598, S-1598a, S-4839); Pikes Peak, 13300 ft. (S-5701, 11963). PARK RANGE—Wheeler Lake, 12300 ft. (S-2724). ELK MOUNTAINS—Gothic Mt., 12646 ft. (10405).

Alpine records of *A. pubescens* have been reported from the Cascade Mountains in Washington (Howard, 1937, 1950, 1955, sub *Parmelia* and Herre, 1946, sub *Parmelia*), the Canadian Rocky Mountains (Fink, 1907, 1919, sub *Parmelia lanata*), Glacier National Park in Montana (Herre, 1946, sub *Parmelia*), Uinta Mountains in Utah (Fink, 1919, sub *Parmelia lanata*), and Mt. La Plata in Colorado (Willey, 1874, sub *Parmelia lanata*).

Alectoria pubescens is not as common in our alpine areas as *A. minuscula*. It appears that *A. pubescens* prefers sheltered areas while *A. minuscula* is more abundant in the drier, more exposed localities. Both species are quite variable and they are frequently very difficult to separate in large collections. The extremes, however, are easily recognized. At first I questioned the occurrence of two species in western America and being convinced that some specimens at least were *A. minuscula* I determined all the material as *A. minuscula* (see comments by Hasselrot, 1953). I have since been convinced that *A. pubescens* also occurs in the region and have reexamined all the collections.

This presents a rather unusual situation in lichen taxonomy. Despite the vast differences of the extremes of each species the large number of intermediates has always been a problem. Different authors have interpreted the same material in different ways. In most cases of two closely related species the distributions are different, even if overlapping. In *A. pubescens-A. minuscula,* however, the distributions are the same. The only difference is an ecological preference but this should not be confused with a geographic difference. Both species are reported in the literature from every area of their distribution. This leads one to question the validity of recognizing two separate species. I have tried to separate my material into two species at several different times with always a few specimens of uncertain position. The individual determinations may, therefore, be questioned by other workers, but I believe the general results will remain the same.

2. ALECTORIA MINUSCULA (Arn.) Degel. Nytt Mag. Naturv. 78: 286. 1938. *Imbricaria lanata* var. *minuscula* Arn. Verh. Zool. Bot. Ges. Wien 28: 293. 1878.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18661, 18662, 18692); Tiffany Mt., 8275 ft. (18718). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7400 ft. (182, 185b, 190, 17360, 17396, 17399); Mt. Fremont, 7100-7200 ft. (17460); Anvil Rock, Mt. Rainier, 9600 ft. (2092); Slate Peak, 7488 ft. (18607a). SIERRA NEVADA—Mt. Whitney, 14495 ft. (17970, 17978, 17988); Kearsarge Pass, 11823 ft. (18029); Piute Pass, 12000 ft. (18065); Mammoth Peak, 12225 ft. (18194, 18209); Mono Pass, 12000 ft. (18114); Parker Pass, 11800 ft. (18218).

Intermontane Plateaus. COLUMBIA PLATEAUS PROVINCE: WALLOWA MOUNTAINS—Eagle Cap, 9675 ft. (18818, 18840, 18845, 18851, 18853, 18856). COLORADO PLATEAUS PROVINCE: LA SAL MOUNTAINS—Mt. Mellenthin, 12890 ft. (16876, 16881, 16896). SAN FRANCISCO MOUNTAINS—Agassiz Peak, 12340 ft. (12714, 12729, 17884, 17897, 17916).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Redoubt Mt., 2830 m. (*Lamb* 6430); Silvertip Mt., 2800 m. (*Lamb* 6348, 6359); Eagle Mt., 2900 m. (*Lamb* 6451); Quartz Hill, 2800 m. (*Lamb* 6466, 6477); Citadel Peak, 2800 m. (*Lamb* 6569). LEWIS RANGE—Altyn Peak, 6000-7500 ft. (5488, 5663); Appekunny Basin, 6000 ft. (5610, 5612, 5647); Swiftcurrent Pass, 7000 ft. (6168, 6172, 6196, 6223); Appekunny Mt., 8500 ft. (6245, 6257, 6259a, 6265, 6290); Goat Mt., 6500-8800 ft. (6329, 6337, 6541, 6546); Reynolds Mt., 7700 ft. (7772); Piegan Pass, 8000 ft. (8078); Dawson Pass, 7500-8000 ft. (8621, 8657, 8661, 8687); Scenic Point, 7600 ft. (8837, 8851). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18784, 18790, 18799, 18799a, 18808, 18814). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9597, 9597a, 9641, 9784). TETON RANGE—Summit Divide, Indian Paintbrush Trail, 10600 ft. (9148, 9190); Pinnacle above Surprise Lake, 9900 ft. (9254). WIND RIVER RANGE—Mt. Lester, 11700 ft. (19058). BIG HORN MOUNTAINS—Loaf Mt., 11000 ft. (*Imshaug*, field data only). UINTA MOUNTAINS—Leidy Peak, 12013 ft. (17204, 17226); Marsh Peak, 12219 ft. (17272). SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18917, 18923). FRONT RANGE—Trail Ridge, 12000-12500 ft. (11201, 11237, 11254); Mt. Evans, 11500-14260 ft. (11041a, 11046, 11051, 11076, 11133, S-279, S-1610, S-1610a, S-1612, S-3394); Pikes Peak, 13000-14100 ft. (S-5662, S-5671, S-5689, S-5690, 11971, 11999a); Longs Peak, 12600 ft. (S-5973, S-10973); Buchanan Pass, 11700 ft. (S-1690). PARK RANGE—Wheeler Lake, 12300 ft. (S-2743, S-2745); Grays Peak, 14274 ft. (S-62); Hoosier Ridge, 13000 ft. (19003, 19026). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11481); Independence Pass, 10100 ft. (11539, 11550, 11555, 11558); Cottonwood Pass, 12700 ft. (11622, 11624, 11635a, 11652a, 11667, 11669); Lake Pass, 12225 ft. (11805); Mt. Massive, 12750-14418 ft. (11854, 11857a, 11861, 11884, 11904a, 11907a, 11919, 11929). ELK MOUNTAINS—Gothic Mt., 12646 ft. (10371, 10377, 10436); Mt. Belleview, 12500 ft. (10511a, 10536); East Maroon Pass, 11850 ft. (10660, 10662, 10668, 10696); White Rock Mt., 13000 ft. (10993a, 11033). SAN JUAN MOUNTAINS—Ridge from Engineer to Gravel Mtns., 13200-13000 ft. (17069, 17115). SANGRE DE CRISTO RANGE—West Spanish Peak, 13623 ft. (12027, 12069); Trinchera Peak, 13546 ft. (12176); Wheeler Peak, 13151 ft. (12290, 12294); Gold Hill, 12660 ft. (12350a, 12386, 12400).

There is an excellent discussion of the variation of this species in Lynge and Scholander (1932). The appressed forms are fre-

quently found in American herbaria under *Parmelia alpicola* and *P. stygia.*

In much of the above cited material the tip of a young filament is raised up from the rock and bends down, forming a small loop. It appears that the tip is firmly attached to the rock when young and further growth is intercalary, thus raising the filament just behind the tip. This type of growth has not been observed in *A. pubescens.*

Section Jubatae DR.

3. ALECTORIA JUBATA (L.) Ach. Lich. Univ. 592. 1810. *Lichen jubatus* L. Sp. Pl. 1155. 1753.

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: PARK RANGE—Hoosier Ridge, 13000 ft. (S-8209). SAWATCH MOUNTAINS—Mt. Massive, 12750 ft. (11886).

This is a common, corticolous species in the forested area but is very rare above timberline. The above collections have soralia and were found in sheltered areas between rocks in the tundra.

Subgenus Alectoria

4. ALECTORIA NIGRICANS (Ach.) Nyl. Lich. Scand. 71. 1861. *Cornicularia ochroleuca* var. *nigricans* Ach. Lich. Univ. 615. 1810.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17489); Moose Lake Trail, 6200-6500 ft. (17588, 17600). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Windy Peak, 8345 ft. (18649, 18699); Slate Peak, 7488 ft. (18573); Pugh Mt., 7150 ft. (18479). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 7100-7400 ft. (17348, 17354, 17359, 17376); Mt. Fremont, 7100-7200 ft. (17431, 17481).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Silvertip Mt., 2650 m. (*Lamb* 6444). LEWIS RANGE—Altyn Peak, 7500 ft. (5683). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9588). SOUTHERN ROCKY MOUNTAINS PROVINCE: PARK RANGE—North Star Mt., 12500 ft. (S-242a).

This species has been found infrequently in rock crevices or in the tundra between stones.

5. ALECTORIA SARMENTOSA (Ach.) Ach. Lich. Univ. 595. 1810. *Lichen sarmentosus* Ach. K. Vet. Acad. Nya Handl. 16. 212. 1795.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Moose Lake Trail, 6200-6500 ft. (17604). CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Mt. Fremont, 7100-7200 ft. (17438); Burroughs Mt., 7100-7400 ft. (17359, 17371).

Alectoria sarmentosa is usually restricted to the forested area below timberline where it is abundant. It is only rarely found in the alpine area.

NEUROPOGON

NEUROPOGON LAMBII Imsh. Rhodora 56: 155. 1954. Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: MIDDLE CASCADE MOUNTAINS—Yakima Park, 6000 ft., Mt. Rainier National Park (*Scholander*, in herb. Farlow). This species is apparently rare since I have been unable to locate it in the vicinity of Yakima Park. Yakima Park is not alpine, but the collection could have come from some alpine ridge nearby.

TELOSCHISTACEAE

XANTHORIA

XANTHORIA CANDELARIA (L.) Kickx, Fl. Crypt. Flandres 1: 229. 1867. *Lichen candelarius* L. Sp. Pl. 1141. 1753. Herre (1913, sub *X. lychnea laciniosa*) reported *X. candelaria* from the summit of Mt. Rose, Nevada. I have not, however, collected this species in any alpine area.

PHYSCIACEAE

PHYSCIA

All the specimens of this genus were studied by Dr. J. W. Thomson and the following treatment of *Physcia* is based entirely on his determinations and comments. I am very grateful to him for this help in a genus which is very difficult in alpine areas because of the depauperate condition of many specimens.

1. Upper surface of the thallus K+ (yellow), containing atronorine.... 2
1. Upper surface of the thallus K—, lacking atronorine..... 9
   2. Marginal cilia present; lobes sorediate, loosely attached to the substrate, ascending.....(*P. leptalea*)
   2. Marginal cilia absent; lobes sorediate or esorediate..... 3
3. Plants sorediate, the soredia in soralia..... 4
3. Plants esorediate..... 7
   4. Soralia capitate (never labriform), on the upper surface of the lobes; lobes $\overline{K}^{+}_{+}$; upper surface white dotted, bluish-gray; underside dark.....*P. caesia*
   4. Soralia labriform (in one species both labriform and capitate soralia present); lobes K± (or medulla faintly K+ yellow); upper surface not white-dotted, gray; underside light..... 5
5. Both capitate and labriform soralia present; lobes narrow, 0.2-0.3 mm.; medulla sometimes faintly K+ (yellow).....*P. intermedia*
5. Only labriform soralia present; medulla K— or K+..... 6
   6. Lobes shorter, broader, over 0.5 mm. broad; medulla K— K+ (yellow).....*P. teretiuscula*
   6. Lobes shorter, broader, over 0.5 mm. broad; medulla K—...*P. dubia*
7. Medulla K—; upper surface light gray, not white-dotted; spores narrow 8-10 μ.....*P. stellaris*
7. Medulla K+ (yellow); upper surface white-dotted..... 8
   8. Upper surface blue-gray; spores narrow, 8-9 μ.....*P. melops*
   8. Upper surface gray, not dark blue-tinged; spores broader, 8.5-11 μ.....*P. aipolia*
9. Thallus isidiate, gray-brown, on rocks or over mosses on rocks.....*P. sciastra*

9. Thallus not isidiate 10
10. Thallus pruinose with a very blue pruina, on soil or over moss; lobes rather broad, up to 4 mm., somewhat concave with the edges raised; apothecia usually pruinose ..... *P. muscigena*
10. Thallus epruinose; lobes narrower, up to 2 mm. broad 11
11. Back of apothecia and underside paraplectenchymatous; 'corona' of rhizinae usually lacking on back of apothecia; lobes 0.2-0.3 mm. broad ..... *P. lithotodes*
11. Back of apothecia with 'corona' of rhizinae, it and lowerside not paraplectenchymatous; lobes 0.5-2.0 mm. ..... (*P. ciliata*)

Subgenus Physcia [= Euphyscia Th. Fr.]
Section Physcia [= Brachysperma (Wain.) Maas G.]
Subsection Tenella (Lynge) Maas G.

PHYSCIA LEPTALEA (Ach.) DC. in Lam. & DC. Fl. Franc. ed. 3. 2: 395. 1805. *Lichen leptaleus* Ach. Lich. Suec. Prodrom. 108. 1798. *Physcia leptalea* cannot be reported with certainty, but a collection (8610) from Dawson Pass, 7500-8000 ft., Glacier National Park, Montana, is possibly this species. The specimen is in poor condition, however, and is not usable as a definite record.

Subsection Stellaris (Lynge) Maas G.

1. PHYSCIA STELLARIS (L.) Nyl. Act. Soc. Linn. Bordeaux 21: 307. 1856. *Lichen stellaris* L. Sp. Pl. 1144. 1753.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: SIERRA NEVADA—Mt. Rose, Carson Range, 10775 ft. (18310).

This specimen is a pruinose lobed form.

2. PHYSCIA AIPOLIA (Humb.) Fürnr. Naturh. Topogr. Regensburg 2: 249. 1839. *Lichen aipolius* Humb. Fl. Friburg. Specim. 19. 1793.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18625: K±).

This is primarily a corticolous species and only rarely is found on rock in alpine areas.

3. PHYSCIA MELOPS Nyl. Flora 57: 16. 1874.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: SIERRA NEVADA—Kearsarge Pass, 11823 ft. (17992).

Subsection Caesia (Lynge) Maas G.

4. PHYSCIA CAESIA (Hoffm.) Fürnr. Naturh. Topogr. Regensburg 2: 250. 1839. *Lichen caesius* Hoffm. Enum. Lich. 65, *pl.* 12, *f.* 1. 1784.

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18907). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11520). ELK MOUNTAINS—White Rock Mt., 13000 ft. (11002, 11006, 11014).

Subsection Tribacia (Lynge) Maas G.

5. PHYSCIA TERETIUSCULA (Ach.) Lynge, Vidensk. Skrift. I. math.-nat. Klasse 8: 96. 1916. *Parmelia caesia* var. *teretiuscula* Ach. Lich. Univ. 479. 1810.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Tiffany Mt., 8275 ft. (18722: K±); Slate Peak, 7488 ft. (18558). SIERRA NEVADA—Parker Pass, 11800 ft. (18219: K±); Bishop Pass, 12000 ft. (18130).

Intermontane Plateaus. COLUMBIA PLATEAUS PROVINCE: WALLOWA MOUNTAINS—Eagle Cap., 9675 ft. (18838).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Scenic Point, 7000 ft. (8881).

In addition to the above specimens, a collection (18118) from Mono Pass, 12000 ft., in the Sierra Nevada, California, may be either *P. teretiuscula* or *P. dubia*. It is too meager, however, to determine with certainty.

6. PHYSCIA INTERMEDIA Wain. Meddel. Soc. Faun. Fl. Fenn. 2: 51. 1878.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: SIERRA NEVADA—Piute Pass, 12000 ft. (18066).

Rocky Mountain System. SOUTHERN ROCKY MOUNTAINS PROVINCE: MEDICINE BOW MOUNTAINS—Medicine Bow Peak, 12000 ft. (18897). SAWATCH MOUNTAINS—Cumberland Pass, 12000-12400 ft. (11518). ELK MOUNTAINS—Mt. Belleview, 12500 ft. (10502, 10529). SANGRE DE CRISTO RANGE—West Spanish Peak, 13600 ft. (12029, 12073).

7. PHYSCIA DUBIA (Hoffm.) Lettau, Hedwigia 52: 254. 1912. *Lobaria dubia* Hoffm. Deutschl. Fl. 156. 1796.

Pacific Mountain System. CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Slate Peak, 7488 ft. (18565). SIERRA NEVADA—Mammoth Peak, 12225 ft. (18195, 18198); Mt. Dana, 13000 ft. (18182).

Intermontane Plateaus. COLUMBIA PLATEAUS PROVINCE: WALLOWA MOUNTAINS—Eagle Cap, 9675 ft. (18823).

Rocky Mountain System. MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9643). TETON RANGE—Static Peak, 11294 ft. (9349). SOUTHERN ROCKY MOUNTAINS PROVINCE: PARK RANGE—Hoosier Ridge, 13000 ft. (19014). SANGRE DE CRISTO RANGE—West Spanish Peak, 13600 ft. (12068).

In addition to the above specimens a collection (18118) from Mono Pass, 12000 ft., in the Sierra Nevada, California, may be either *P. dubia* or *P. teretiuscula*. It is too meager, however, to determine with certainty.

PHYSCIA TRIBACIA (Ach.) Nyl. Flora 57: 307. 1874. *Lecanora tribacia* Ach. Lich. Univ. 415. 1810. Herre (1913) has reported *P. tribacia* from the summit of Mt. Rose, Nevada. It is unlikely, however, that this species occurs on the summit of Mt. Rose. The voucher specimen could not be located in the herbarium of the Chicago Natural History Museum.

Subsection Obscura (Lynge) Maas G.

PHYSCIA CILIATA (Hoffm.) DR. Sv. Bot. Tidskr. 15: 168. 1921. *Lichen ciliatus* Hoffm. Enum. Lich. 69, *pl.* 14, *f.* 1. 1784. *Physcia ciliata* cannot be

reported with certainty, but a collection (12395) from Gold Hill, 12660 ft., Sangre de Cristo Range, New Mexico, is probably this species, although it may be *P. lithotodes*.

8. PHYSCIA LITHOTODES Nyl. Flora 58: 360. 1875.

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Altyn Peak, 7500 ft. (5701); Scenic Point, 7600 ft. (8847). SOUTHERN ROCKY MOUNTAINS PROVINCE: SAN JUAN MOUNTAINS—Blue Lake Pass, 12500 ft. (16983).

In addition to the above a collection (12395) from Gold Hill, 12660 ft., Sangre de Cristo Range, New Mexico, is probably *P. ciliata* but may be *P. lithotodes*.

9. PHYSCIA SCIASTRA (Ach.) DR. Sv. Bot. Tidskr. 15: 168. 1921. *Parmelia sciastra* Ach. Meth. Lich. Suppl. 49. 1803.

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: LEWIS RANGE—Garden Wall above Grinnell Glacier, 8000 ft. (8474); Altyn Peak, 7500 ft. (5707). SOUTHERN ROCKY MOUNTAINS PROVINCE: FRONT RANGE—Mt. Evans, 12000 ft. (S-2899). ELK MOUNTAINS—White Rock Mt., 13000 ft. (11006, 11013). SAN JUAN MOUNTAINS—Ridge between Engineer and Gravel Mtns., 13200 ft. (17079).

Collection no. 8474 represents f. ERIGENS (Wain.) Nadv.

Subsection Pulverulenta (Lynge) Maas G.

10. PHYSCIA MUSCIGENA (Ach.) Nyl. Act. Soc. Linn. Bordeaux 21: 308. 1856. *Parmelia muscigena* Ach. Lich. Univ. 472. 1810.

Pacific Mountain System. PACIFIC BORDER PROVINCE: OLYMPIC MOUNTAINS—Obstruction Point, 6450 ft. (17532, 17568, 17570); Moose Lake Trail, 6200-6500 ft. (17597). CASCADE-SIERRA MOUNTAINS PROVINCE: NORTHERN CASCADE MOUNTAINS—Tiffany Mt., 8275 ft. (18732); Slate Peak, 7488 ft. (18602, 18603). MIDDLE CASCADE MOUNTAINS—Burroughs Mt., 6500-7300 ft. (189). SIERRA NEVADA—Mammoth Peak, 12225 ft. (18210); Mt. Dana 13000 ft. (18182); Bishop Pass, 12000 ft. (18139, 18141); Mono Pass, 12000 ft. (18095); Piute Pass, 12000 ft. (18083); Mt. Whitney, 14495 ft. (17937, 17948, 17958, 17960, 17977).

Intermontane Plateaus. BASIN AND RANGE PROVINCE: SNAKE RANGE—Wheeler Peak, 13061 ft. (17301, 17315, 17338). COLORADO PLATEAUS PROVINCE: SAN FRANCISCO MOUNTAINS—Agassiz Peak, 12340 ft. (17891).

Rocky Mountain System. NORTHERN ROCKY MOUNTAINS PROVINCE: BOW RANGE—Mt. Rundle, 7000-8300 ft. (6609, 6616). LEWIS RANGE—Altyn Peak, 7500 ft. (5651, 5654); Goat Mt., 8800 ft. (6529); Reynolds Mt., 7700 ft. (7740); Piegan Pass, 8000 ft. (7976, 8017, 8062); Garden Wall above Grinnell Glacier, 8000 ft. (8448, 8485); Dawson Pass, 7500-8000 ft. (8636); Scenic Point, 7600 ft. (8855, 8878); Siyeh Pass, 8200 ft. (9004). FLINT CREEK RANGE—Mt. Powell, 10213 ft. (18783). LOST RIVER RANGE—Leatherman Pass, 10000 ft. (16569, 16590). PIONEER MOUNTAINS—Hyndman Pass, 11000 ft. (16634). MIDDLE ROCKY MOUNTAINS PROVINCE: BEARTOOTH RANGE—Beartooth Pass, 11000 ft. (9638, 9728). TETON RANGE—Pinnacle above Surprise Lake, 9900 ft. (9251); Static Peak, 11294 ft. (9324,

9340, 9347). Wind River Range—Mt. Lester, 11700 ft. (19073, 19112). Big Horn Mountains—Loaf Mt., 11000 ft. (19131, 19148). Uinta Mountains—Leidy Peak, 12013 ft. (17219); Bald Mt., 11300-11947 ft. (16744, 16773). Wasatch Mountains—Mt. Baldy, 11049 ft. (16806). Southern Rocky Mountains Province: Medicine Bow Mountains— Medicine Bow Peak, 12000 ft. (18893). Front Range—Trail Ridge, 12000 ft. (11227, 11232); Mt. Evans, 12500-14260 ft. (11049, 11086, 11135, 11138, S-271, S-1615, S-2927, S-2928); Upper Green Lakes north of Kiowa Peak (S-1449); Pikes Peak, 14100 ft. (S-5675). Park Range—Wheeler Lake, 12300 ft. (S-2769, S-2774); North Star Mt., 12500 ft. (S-2704); Hoosier Ridge, 13000 ft. (18974, 18976, 18978, 18985, 19035). Sawatch Mountains —Mt. Massive, 12750-14418 ft. (11860, 11916); Independence Pass, 12900 ft. (11601); Lake Pass, 12225 ft. (11779). Elk Mountains—North Italian Peak, 11000-13300 ft. (S-6236); East Maroon Pass, 11850 ft. (10710); White Rock Mt., 12800-13000 ft. (10980, 10994); Virginia Basin, 12000 ft. (10626); Virginia Ridge, 12300-12400 ft. (10584, 10588); Gothic Mt., 12646 ft. (10417); Conundrum Pass, 11700 ft. (S-5837). San Juan Mountains— Blue Lake Pass, 12500 ft. (16975, 17017, 17032, 17043); Ridge between Engineer and Gravel Mtns., 13200 ft. (17094, 17097). Sangre de Cristo Range—West Spanish Peak, 13623 ft. (12071); Trinchera Peak, 13546 ft. (12201); Wheeler Peak, 13151 ft. (12243, 12270, 12274); Gold Hill, 12660 ft. (12382).

This is a very common species on soil or over decaying plant material in alpine areas. The variations may be recognized under the following names: f. alpina Nadv. (8017, 18974); var. isidiata Lynge (16773); f. lenta (Ach.) Wain. (10417, 10584, 10588, 10980, 11860, 11916, 16975); f. squarrosa (Ach.) Lynge (5651, 7976, 9638, 11049, 11086, 17301, 17568, 17958, 17960, 17977, 18083, 18210).

Lichenes Imperfecti

Thamnolia

1. Thamnolia vermicularis (Sw.) Schaer, Enum. Critic. Lich. Europ. 243. 1850. *Lichen vermicularis* Sw. Meth. Musc. 37. 1781.

Pacific Mountain System. Pacific Border Province: Olympic Mountains—Obstruction Point, 6450 ft. (17559). Cascade-Sierra Mountains Province: Northern Cascade Mountains—Windy Peak, 8345 ft. (18668); Tiffany Mt., 8275 ft. (18756); Pugh Mt., 7150 ft. (18503). Middle Cascade Mountains—Burroughs Mt., 6500-7400 ft. (184, 17395).

Rocky Mountain System. Northern Rocky Mountains Province: Bow Range—Mt. Rundle, 7000 ft. (6624); near Victoria Glacier (6939); Silvertip Mt., 2500 m. (*Lamb* 6443); Sulphur Mt., 2500 m. (*Lamb* 6186); Quartz Hill, 2650 m. (*Lamb* 6465). Lewis Range—Appekunny Basin, 6000 ft. (5616); Altyn Peak, 7500 ft. (5676); Appekunny Mt., 7000-8500 ft. (6286, 6293, S-3154); Swiftcurrent Pass, 7000 ft. (6116); Goat Mt., 8800 ft. (6491); Reynolds Mt., 7700 ft. (7788); Swiftcurrent Mt., 8300 ft. (7844, 7890); Piegan Pass, 8000 ft. (8070); Garden Wall above Grinnell Glacier, 8000 ft. (8429, 8487); Dawson Pass, 7500-8000 ft. (8605, 8653); Scenic Point, 7600 ft. (8839); Siyeh Pass, 8200 ft. (9007) Middle Rocky Mountains Province: Beartooth Range—Beartooth Pass, 11000 ft. (9608, 9696, 9762). Wind River Range—Mt. Lester, 11700 ft. (19069). Southern

Rocky Mountains Province: Medicine Bow Mountains—Medicine Bow Peak, 12000 ft. (18901). Front Range—Trail Ridge, 12000 ft. (S-1417, 11199); Mt. Evans, 11500-13100 ft. (11108, S-269, S-3753); Pikes Peak, 13300 ft. (11935, S-5697); above Fool Creek, 11500 ft. (S-1672); Longs Peak, 11050 ft. (S-1505); Green Lake Valley between Green Lake IV and Kiowa (S-474). Park Range—Hoosier Ridge, 13000 ft. (18998); North Star Mt., 12300 ft. (S-2854). Sawatch Mountains—Cumberland Pass, 12000-12400 ft. (11506); Independence Pass, 12100 ft. (11573); Cottonwood Pass, 12700 ft. (11639); Lake Pass, 12225 ft. (11783); Mt. Massive, 12750-14418 ft. (11876, 11897); two miles southeast of Monarch Pass, 12000 ft. (S-10290). Elk Mountains—Conundrum Pass, 12300 ft. (S-5813); North Italian Mt., 13200 ft. (S-398); Gothic Mt., 12600 ft. (10388); White Rock Mt., 12800 ft. (10981); Virginia Ridge, 12300-12400 ft. (10563); Virginia Basin, 12000 ft. (10622); East Maroon Pass, 11850-12000 ft. (10664, S-1985). West Elk Mountains—Ohio Peak, Anthracite Range, 9500-12000 ft. (S-6297). San Juan Mountains—Blue Lake Pass, 12500 ft. (16970); Ridge between Engineer and Gravel Mtns., 13200 ft. (17068). Sangre de Cristo Range—Trinchera Peak, 13500 ft. (12189); Wheeler Peak, 13100 ft. (12265); Gold Hill, 12660 ft. (12380, 12409).

Alpine records of *Thamnolia vermicularis* have been reported from the Cascade Mountains in Washington (Howard, 1937, 1950), the Lake Louise area in the Canadian Rocky Mountains (Fink, 1907, 1919) the Medicine Bow Mountains in Wyoming (Bliss, 1956), Baldy Peak in New Mexico (Bouly de Lesdain, 1932) and various localities in Colorado (Weber & Shushan, 1955).

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SCHUSTERIA, A NEW GENUS OF LEJEUNEACEAE

P. KACHROO[1]

While undertaking a revision of the genus *Taxilejeunea* (*sensu* Stephani's *Species Hepaticarum*), in continuation of my study of the genera of Lejeuneaceae, I had occasion to examine *Taxilejeunea tonduzana* Steph., and it immediately struck me as a species that had no affinities with *Taxilejeunea* s. str. The striking features of this plant are the very short insertion of the lobe and lobule on the axis; the lobule with two marginal teeth; the apical tooth large, 2-5 cells long and with a base 2-3 cells broad; the hyaline papilla of the lobule displaced inwardly to the base of the apical tooth; the gynoecia borne on very much abbreviated shoots with a single leaf in addition to the bracts; the small gynoecial bracteoles free; subfloral innovations absent; the stem with only three medullary cell rows; the underleaves bifid nearly to the base, the lobes lanceolate, acute to acuminate and very strongly divergent; and the probable presence of gemmae and ocelli. These features at once differentiate the species from *Taxilejeunea*. A comparison of *Taxilejeunea tonduzana* with other genera of the Lejeuneaceae showed that it represents a well-defined and separate entity, and it is proposed as a new genus:

Schusteria n. gen.[2] Plants delicate, 1.1 mm. wide, olive- to

[1] Malaria Research Laboratory, Damodar Valley Corporation, Burdwan, West Bengal, India.

[2] Planta tenuis, parva, 1.1 mm. lata, vel olivacea vel pallide viridis, nec fusca, nec nitida. Caules prostrati, vix ramosi, ex seriebus 7 cellularum exteriorum constantes et 3 interiorum, ca. 580 μ diametientes; cellulis omnibus modice et tenuiter vallatis. Folia subimbricata, late patentia; lobo ovato applanato, apice rotundo, a basi brevissimo (ca. cellulis tribus) lato ad axem inserto, basi distincte cordato, trans caulem extento, quam lobulo parvo sextuplo vel quatro longiori. Lobulus ad basem brevissimus (2 vel 3 cellulis) ad axem adfixus, haud vel vix inflatus, typice obovatus, margine libera duobus dentibus marginalibus conspicui praedita; dente apicali magno, suberecto vel sensim obliquo, ex cellulis longitudinaliter 2-4 et transversaliter 2 vel 3 constante; dente proximo in lobulis insanibus abortivo, sed in lobulis maturis distincto, angulato vel obtuso, medialiter inter lobuli basem et carinae apicem sito; carina leviter convexa cum margine lobi libera posteriori continua; papilla hyalina vel ad superficiem sub dentem posita, haud in margine, sinu oblique truncato vel lunato. Cellulae folii parvae, aequaliter incrassatae, sine trigonibus claris; incrassationibus, intermediis nullis; cellulae basales duplo vel quintuplo longiores quam latiores. Ocelli nondum visi, sed cellulae probabiliter initiales gemmarum supra folii superficiem dispersae. Folia inferiora solum unum pro 2 lateralia, distantia, bifida approximate usque ad basem, lobis lanceolatis, valde divergentibus, anguste acutis vel acuminatis. Reproductio probabiliter gemmis discoideis, sed non visa.

Dioica. Gynoecia sine innovationibus subfloralibus, in ramis brevissimus ex caule primario foliaceo omnibus unilateraliter orientibus; folio parvo uno

light-green, neither fuscous nor glossy. Stems *prostrate, very slender* (about 580 μ in diameter), very sparingly branched, with *7 rows of cortical cells* enclosing *3 rows of medullary cells* which are only slightly less in diameter than the cortical cells, all cells rather thin-walled. Leaves *loosely imbricated,* widely spreading; lobe ovate, plane, *rounded at apex, entire-margined, inserted by a very short base* (about 3 cells wide) *on the axis,* the base distinctly cordate, arching across and beyond the stem. Lobule small, 1/6-1/4 *the length of lobe, inserted on the axis by a very short base, about* 2-3 cells wide, not or weakly inflated, when well developed obovate, the *free margin with 2 strong marginal teeth;* the *apical tooth large, suberect to slightly oblique, 2-4 cells long, 2-3 cells wide at base;* the proximal tooth absent on weakly-developed lobuli, on mature lobuli distinct, angulate, or blunt, situated midway between the base of the lobule and apex of the keel; keel weakly convex, continuous with the free posterior margin of lobe; the *hyaline papilla displaced inwardly,* situated below the base of apical tooth; sinus oblique-truncate to crescentic. Leaf cells *small, equally thickened,* without sharply defined trigones, *intermediate thickenings absent;* basal cells 2-5 × *as wide as long. Ocelli presumably present,* scattered. (A number of ocelli-like cells are scattered over the surface of the leaf; some are probably initials of the gemmae.) Underleaves *one per pair of lateral leaves,* distant, *bifid to near base,* the lobes lanceolate, *strongly divergent,* narrowly acute to acuminate. *Asexual reproduction presumably by means of discoid gemmae.*

Dioecious. Gynoecia borne on *much abbreviated shoots, the latter with a very small single leaf in addition to the bracts,* the female shoots borne laterally on the main leafy shoots, along the same side; gynoecia *without subfloral innovations.* Bracts *very small,* about 0.5 the length of leaves, obliquely spreading, shortly and unequally bifid; lobe lanceolate-oblong, subacute to subrotund at apex; lobule 0.75 the length of lobe, similar to it in shape, rarely emarginate at apex; lobe and lobule entire-margined. Bracteole *smaller than underleaves* but similar to them in shape, *free.* Perianth *not compressed,* obovate-obpyriform, exserted 3/4 beyond the bracts, apex rather subrotund with a distinct *short beak; 5-plicate*

praedita. Bracteae parvissimae brevissimae et inaequaliter bifidae, oblique patentes, lobo oblanceolato, apice subobtuso; lobulo quam lobo parte quarta breviori, circumscriptione simili, rarum apice emarginato; ambobus integris. Bracteola quam folia inferiora parvior sed iis similis, libera. Perianthium haud compressum, obovate obpyriforme, tribus partibus ultra bracteas exsertum, apice obtusum, umbonatum, prope apicem in parte tertia 5-plicatum, dorsaliter 1-plicatum, plica laevi, obtusa. Androecia in ramis lateralibus brevibus; bracteis paucis, valde inflatis; bracteola solitaria ad basem rami.

in the distal 1/3, dorsal surface with a single plica, *plicae blunt, smooth*. Androecia on short lateral shoots, bracts few, strongly inflated; *bracteole restricted to the base of the male spike*.

TYPE: **Schusteria tonduzana** (Steph.) n. comb. *Taxilejeunea tonduzana* Steph., Sp. Hep. 5: 498. 1914. Costa Rica.

The genus is named in honor of Dr. R. M. Schuster, the distinguished young American hepaticologist, a sincere and close friend who introduced me to the confused jungle of the Lejeuneaceae.

Schusteria bears rather close affinities with a new subfamily to be proposed by Schuster and Kachroo (*unpubl.*) and to include *Tuyamaella* Hatt. and *Siphonolejeunea* Herz. It resembles *Tuyamaella* in the very narrow insertion of the lobe and lobule; the lobule with two marginal teeth and the hyaline papilla displaced inwardly; the 5-carinate perianth; the presence of discoid gemmae; and stem anatomy. However, *Tuyamaella* differs from *Schusteria* in the following characters: the gynoecia are borne on leading, or short to elongated lateral leafy shoots, always provided with subfloral innovations; the perianth is compressed (whereas in *Schusteria* the perianth is not compressed and is 5-plicate only in the distal one-third to one-fourth); the underleaves are obovate and not deeply bifid. The lobes are broad, rotund to blunt, suberect and not or scarcely divergent; the androecia are borne terminally on the main leafy shoots, proliferating and with bracteoles along the entire length of the spike; the bracteole is united with one of the perichaetal bracts at base; and ocelli are absent.

Features shared by *Schusteria* and *Siphonolejeunea* are the very short insertion of the lobe on the axis, the deeply bifid underleaves and the 5-carinate perianth. However, other features of *Siphonolejeunea* are so divergent that a comparison is uncalled for.

Schusteria shows close superficial similarities to *Diplasiolejeunea*, with which it agrees in leaf shape and insertion; the bidentate lobuli; the small gynoecial bracts; the 5-carinate perianth; the small, thick-walled leaf-cells; the deeply bifid and divaricate-lobed underleaves; the stem anatomy; the development of gemmae from leaf surfaces; the position of the hyaline papilla of the lobule; the closely prostrate growth; and the very slender stems. Two features sharply isolate the genus from *Diplasiolejeunea:* the occurrence of one underleaf per leaf pair and the restriction of the gynoecia to short lateral branches lacking innovations.

Stephani, who referred the generitype to *Taxilejeunea*, quite misinterpreted the gynoecial position. *Taxilejeunea*, as is well known, possesses gynoecia on short lateral branches which inno-

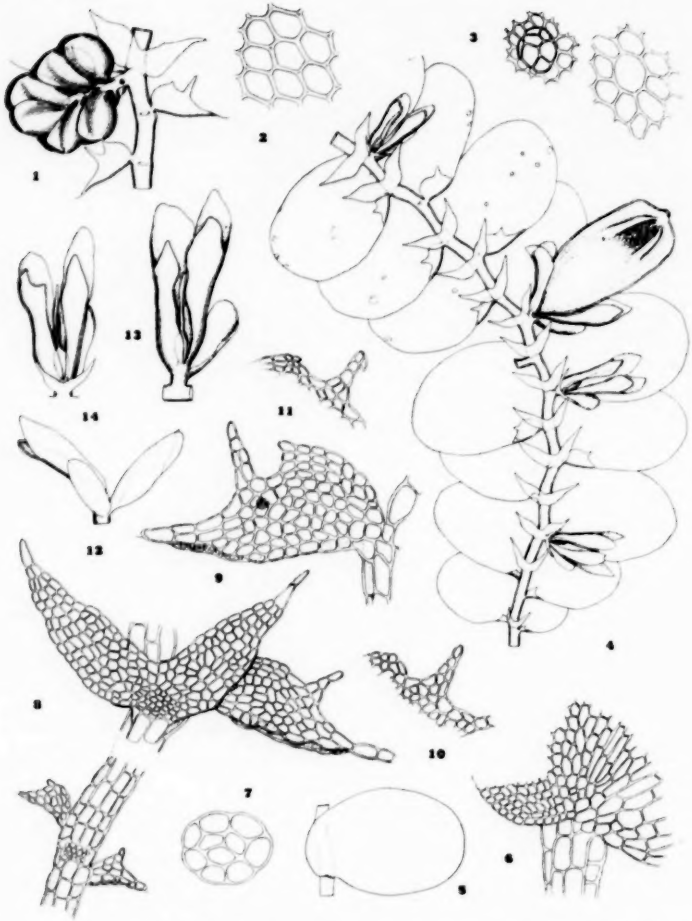

FIG 1-14. *Schusteria tonduzana*. 1. Portion of a male plant, postical view, × 63. 2. Leaf cells, × 368. 3. Same, showing an ocellus and gemma, × 275. 4. Female plant, postical view, × 35. 5. Leaf, dorsal view, × 38. 6. Insertion of leaf on axis, dorsal view, × 165. 7. Cross-section of stem, × 300. 8. Portion of a shoot, postical view, × 165. 9. Lobule, showing two marginal teeth, hyaline papilla and very short insertion on the axis, postical view, × 235. 10-11. Apices of lobules, × 235. 12. Abbreviated female shoot (perianth removed), dorsal view, × 55. 13-14. Same with archegonia, postical view, × 75. (The figures were drawn from specimens from *Bryotheca E. Levier* in herb. Yale Univ. Dissections are in herb. Schuster, no. 38190.)

vate, the innovations being soon fertile, and again innovating, thus typically resulting in apparently superficially continuous lateral axes bearing juxtaposed and serially arranged gynoecia. Such a superficially similar arrangement is also characteristic of *Schusteria*, in which it is arrived at in a fundamentally different manner: the leading (not secondary!) leafy axes produce, along one side of the stem, repeated short gynoecial branches bearing a single leaf, then cutting off the bracteole and bracts. These gynoecial branches are so short that it could easily be assumed that they do not exist and that, therefore, pseudolateral gynoecia of the *Taxilejeunea*-type are at hand. However, this is not the case; the gynoecia actually occur singly on exceedingly abbreviated lateral branches and are thus truly lateral rather than pseudolateral. In this respect, *Schusteria* resembles *Cladiantholejeunea* Herz., a genus to which no close affinities exist.

I am indebted to Dr. R. M. Schuster for his suggestions and criticism and to Dr. K. L. Jones (Univ. of Michigan) for laboratory facilities and encouragement. Thanks are due to Dr. J. R. Reeder for the loan of the Yale University collection of *Taxilejeunea* and to Prof. H. H. Bartlett for preparation of the Latin diagnosis.

THE EFFECT OF INDOLE-3-ACETIC ACID ON CERTAIN GROWTH PHASES IN BRYOPHYTES

PAUL M. PATTERSON[1]

Very few publications have dealt with the effects of indole-3-acetic acid or other active growth promoting substances[2] on the bryophytes. The earliest publication on this subject known to the writer, that of Fitting (1939), utilizing beta indolyl acetic acid, was incidental to a more comprehensive physiological study. He found that the inhibition of rhizoidal production induced by darkness in the case of marchantiaceous gemmae was overcome with the above acid at concentrations of 10^{-6} to 10^{-7}.

Witsch (1940) demonstrated the natural occurrence of "Wuchsstoff" in the hepatic *Calypogeia trichomanis* by the *Avena*-test and found that it was present in concentrations comparable with those in many flowering plants. He showed that 1-5 gamma per liter enhances early growth.

[1] Hollins College, Virginia.

[2] The usual abbreviations for these growth promoting substances are used: IAA for indoleacetic acid; IBA, indolebutyric acid; NAA, naphthaleneacetic acid; 2,4-D, 2,4-dichlorophenoxyacetic acid.

The first publication on this subject in the United States is that of LaRue (1942), who stimulated rhizoidal production with IAA and IBA in lanolin on detached leaves and sporophytes of several species of mosses and on the cut thallus of *Conocephalum conicum*. The only other publication in this country is that of Prior (1952), who showed that the concentrations of 2,4-D normally used in herbicides are harmless to *Mnium cuspidatum* and *Brachythecium salebrosum*.

The several investigators in this field express the concentrations of their growth promoting substances in a variety of ways. We have chosen to express the concentrations in terms of the weight of the dissolved chemical to water logarithmically.

About half of the literature is concerned with determining the concentrations most effective for the germination of spores or of the growth of protonema, or of other growth sequences: Fries (1943), *Funaria* protonema (IAA optimum at 10^{-8}); Bopp (1953), protonematal growth in *Funaria*, and buds formed from detached leaves (IAA at 10^{-8}); Rousseau (1950), the induction of rhizoids on the dorsal surface of gemmae of *Marchantia* and *Lunularia* (IAA at 10^{-4} to 10^{-8}); Rousseau (1951), the elongation of gemmae cups in the same species (NAA, at 10^{-3} to 10^{-4}); Moewus & Schader (1952) used beta-indoleacetic acid singly and in combination with coumarin and other substances on rhizoid production in *Marchantia* and found that with the IAA used singly promotion of rhizoidal growth occurred between 10^{-6} and 10^{-8}; Benson-Evans & Powell (1953), elongation of archegonial stalks of *Conocephalum* (Na salt of 2,4-D at 10^{-6}); Benson-Evans (1953), spore germination in *Mnium hornum* (2,4-D in greater dilution than 10^{-6}).

Other investigators concern themselves with higher concentrations than these and demonstrate the role of these chemicals in the suppression of a growth phase or in the resulting abnormal growth-forms: Hurel-Py (1948), on the inhibitory effects of the production of leafy shoots on *Funaria hygrometrica* (NAA 10^{-7} to 10^{-9}, partial; 10^{-5}, complete); Kofler (1951), anomalies in leafy shoots produced from *F. hygrometrica* protonema (2,4-D. at 10^{-5} and 10^{-7}, particularly the former); Rousseau (1953), effects on growth of thallus of *Marchantia* and *Lunularia* (using eight active chemicals); Kofler (1953), effect on sods of *Funaria* (Na-salt of 2,4-D at 10^{-4} when sprayed at the rate of 5 cc. per sq. dm.); and Rousseau (1954), the effect on *Riccia crinacea* thalli (NAA and 2,4-D at 10^{-4} and $10^{-4} \times .05$).

As seen above, growth promoting concentrations of IAA lie between 10^{-6} and 10^{-8}, and concentrations between these limits were used in this investigation: namely, 1.0, 0.5, 0.1 and 0.01 parts IAA by weight per million parts of water (ppm.). The culture medium contained the following minerals: $MgSO_4$, KH_2PO_4 and $Ca(NO_3)_2$ at a concentration of 0.5 millimoles each. $FePO_4$ was added at the rate of 0.5 ppm. and the trace elements, $ZnCl_2$, $MnSO_4$ and $Na_2B_4O_7$, at the rate of 0.1 ppm. each. For solid media, 1.5% purified agar prepared by the Difco Laboratories was added. Solid

media were autoclaved, distributed to sterile petri dishes and sealed with a strip of "parafilm" after sowing spores. The *p*H of the control and the IAA series approximated 6.6.

The following method was used in scattering spores on sterile media. Ripe but unopened capsules were dipped in 70% ethyl alcohol and blotted on sterile filter paper; the operculum was removed with sterile forceps, and a light sprinkling of spores was placed on the surface of the agar on the control and the several IAA concentrations from a single capsule. When spores fell in clumps, distribution was effected by streaking. The above procedure was carried out on the stage of a low-power binocular microscope.

The effectiveness of this method was uniformly good as no bacterial or mold colonies appeared at the spots where the spores were strewn. However, since the plates were exposed completely for 20-30 seconds or more in this procedure, random seeding of the plates with mold spores often occurred. The mold colonies were generally low and thin and grew very slowly. The mold that usually grew was *Alternaria*. Molds, of course, occurred on plates where IAA stimulation was apparent. To eliminate the possibility that the source of the stimulation emanated from the mold, controls were set up later in duplicate, and the mold in question was innoculated at the site of the protonematal culture in one of the controls. The result in each case was a slow and usually minor retardation of protonematal growth as compared with that in the duplicate control. Thus the occurrence of colonies of molds for a short period of time was disregarded.

For gemmae and other non-sterile tissues, the unsterilized medium without agar was poured over pads of cotton in petri dishes and the transplant placed on filter paper on top of the cotton "sponge." These dishes were closed and placed in glass humidors to retard evaporation.

Illumination for all cultures was bright diffuse light in a corner of the laboratory between large northeast and northwest windows. Temperature was uncontrolled and was that prevailing during June to August. The cultures slowly accumulated colonies of molds, but observation could usually be made for 10 days or two weeks before the molding became conspicuous.

Experiments with Spore Germination and Protonematal Growth

Spores of a number of species failed to germinate under the conditions of these experiments and were discarded after six to eight weeks: *Anastrophyllum michauxii*, *Diplophyllum apiculatum*, *Cephalozia catenulata* and *Calypogeia succica*. *Diphyscium folio-*

sum spores were streaked while still immature as they were hanging together in tetrads and suspended in the liquid content of the spore sac. These failed to mature and germinate.

PLATYLOMELLA LESCURII (Sull.) Andrews. The spores in all cultures germinated promptly (50% in 24 hours, 100% in 48 hours), but retardation in the elongation of the protonematal filaments became apparent in about six days in 0.5 and 1.0 ppm. IAA. There was a very slight increase in elongation in the 0.01 as compared with the control after four weeks, with the longest filaments at 180 μ as compared with 160 μ in the control. The 0.1 matched the control; thus, at these lower concentrations, stimulation of cell division and elongation were negligible.

POLYTRICHUM JUNIPERINUM var. ALPESTRE BSG. Spores had all germinated by the seventh day with the 0.5 ppm. culture taking the lead in growth and development from the start. The nearest competitor, 0.1 ppm., had molded after the tenth day to such an extent that the culture was discarded. This moss sends out on opposite sides of the spore germ tubes from which protonematal branches arise radially. Seventeen days after sowing, or a week after germination, the radial branches were 4-5 cells long in the 0.5 ppm. culture with as many as three secondary branches arising from them. The radial branches had reached the length of a millimeter. In the control radial branches 2-4 cells long had not yet produced secondary branches and had grown to a maximal length of 0.5 mm. Growth in 0.01 and also 1.0 was strongly retarded, showing at this time only the bipolar 1-2-celled germ tube. No explanation of the inhibition in the 0.01 culture is apparent unless it was a mislabeled 1.0 culture.

LESKEA GRACILESCENS Hedw. Spores began germinating after a week. The cult re in 0.01 medium was rapidly lost in molds. A week later 0.5 s..owed 100% germination with 0.1 at 50%, 1.0 at 20% and the control at 10% At the close of the experiment, 26 days after sowing, the control had 40% germination. In the 0.5 medium protonematal filaments up to 18-21 cells long with beginning secondary protonematal branches were produced, while the protonemata in the other media had attained a length of only 1-3 cells.

SPHAGNUM PALUSTRE L. Spores began to germinate after six days, and by the seventh day germination was about 100% except that several days longer were required in the 0.5 and 1.0 media. The germ tube elongates and swells to a small bulb at its distal end and is then cut off from the germ tube. This is the primordium for the many-celled prothallus that is formed with at least a tran-

sient 2-sided apical cell as described by Bold (1948). At the end of two weeks from sowing date the prothalli in 0.01 were up to 15-celled and had produced 1-2 rhizoids each; in 0.1 up to 20-celled with 2-3 rhizoids; in 0.5 up to 12 cells usually with 1 rhizoid; in the 1.0 medium prothalli were 1-5-celled, while the control had 1-2-celled prothalli.

Since the normal habitat of *Sphagnum* has an acid reaction, the near neutral medium used is perhaps unfavorable to growth as reflected in the control. While the traces of IAA added to this medium did not lower the *p*H perceptibly by colorimetric measurements, the lower IAA concentrations accelerated growth strongly.

DRUMMONDIA PROREPENS (Hedw.) Jenn. This species gave tardy and poor germination and growth under the conditions of culture. The same series of cultures was set up with the exception of 1.0 IAA. The first suggestion of germination occurred in the 0.1 culture after five days. After 18 days the 0.01 culture gave a 38% germination with the longest filaments 560 μ long; 0.1 about 1% germination with the longest filaments about 120 μ. In 0.5 spores failed to germinate; the control showed about 1½% germination with the longest filaments 80 μ. While there was no spectacular growth here, the medium with the 0.01 ppm. IAA showed a clear acceleration over the other cultures.

EXPERIMENTS WITH THE DEVELOPMENT OF PROPAGULA

DICRANUM FLAGELLARE Hedw. The production of protonematal filaments was visible after the third day, and growth during the next 10 days was fairly rapid. The control had well branched protonemata with maximum growth of 1450 μ and was superior to all of the IAA series. The 0.01 culture approached it most closely with well branched protonemata with maximum growth of 1160 μ. The higher concentrations showed retardation in growth and blackening of the cells of the propagula and increase in the proportion of rhizoidal filaments.

AULACOMNIUM PALUSTRE (W. & M.) Schwaegr. All cultures grew rapidly with fairly abundant protonematal threads and attained a maximum length of 4 mm. in 13 days. Little difference could be seen in these cultures except that the threads were sparser in the 1.0 ppm. concentration.

TORTULA PAGORUM (Milde) DeNot. The control showed normal growth and the 0.01 approached it closely. Increase in length of rhizoids was stimulated by IAA giving greatly elongated cells and elongated rhizoidal branches with increase of concentration of IAA. Side branches were inhibited during the three-week culture

in the 0.5 and 1.0 concentrations, and there was an increase in dying gemmae from 15% in the 0.5 to 50% in the 1.0.

Elongation of Setae and Pseudopodia

Frullania saxicola Aust. and F. asagrayana Mont. with half-grown capsules were kept wet with this series of IAA concentrations and mineral control for two weeks without forcing the elongation of the cells of the seta.

Sphagnum palustre with mature or nearly mature capsules but with unelongated pseudopodia was kept wet with the same series. The 0.01 concentration gave the most prompt response, rapidity of growth and greatest elongation of the pseudopodium, reaching a maximum growth in three to four days, with the 0.1 rather less effective. Higher concentrations prevented elongation. Growth was slower in the control, and elongation was not as pronounced. Since only a few fruiting plants were available, these observations are essentially preliminary.

Summary

Mineral medium alone and others with IAA in concentrations of 1.0, 0.5, 0.1 and 0.01 ppm. were used. The spores of several species failed to germinate on these media. In five species where the spores germinated, the percentage of germination was increased (*Leskea gracilescens* at 0.5 ppm. and *Drummondia prorepens at* 0.01 *ppm.*). IAA accelerated early protonematal growth in four out of the five species with the optima varying in the several species from 0.01 to 0.5 ppm. Propagula of three species of mosses were grown without acceleration at the lowest concentration but with progressive inhibition in the stronger ones. The elongation of the pseudopodium of *Sphagnum palustre* was most rapid in IAA at 0.01 ppm.

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RECENT LITERATURE ON LICHENS—23[1]

WILLIAM L. CULBERSON[2]

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———. Lichenologische Notizen (§ 124-125). *Ibid.* 32(4): 97-100. 2 *fig.* 1957. [New: *Megalospora nipponensis* n. sp., *Parmelia* (Hypotrachyna) *subscortea* n. sp.]

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[1] Names of new taxa from the Americas are marked with an asterisk (*).

[2] Dept. of Botany, Duke University, Durham, N. C.

BLAKE, S. F. Review of the genus *Cladonia* in the District of Columbia and vicinity. Rhodora 59(699): 56-61. 1957. [38 spp.]

BOULY DE LESDAIN, M. Notes lichénologiques. N° XLI. Bull. Soc. Bot. France 103(5-6): 270-272. 1956. [New: *Ramalina prinii* n. sp., *R. polymorpha* v. *tenuissima* n. v., *R. fastigiata* f. *granulata* n. f. and f. *lacerata* n. f., *Placolecanora circinata* v. *urbana* n. v. and *Placodium circinatum* v. *urbanum* n. v. [*sic*], *Lecania clauzadei* n. sp.]

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DODGE, C. W. Some lichens of tropical Africa. II. *Usnea*. Ann. Missouri Bot. Gard. 43: 381-396. 1956; 44: 1-76. 1957. [102 spp. Key. New: *U. cervicornis* n. sp., *U. nutans* n. sp., *U. dodomae* n. sp., *U. pulvinata* n. sp., *U. subcristata* n. sp., *U. nana* n. sp., *U. medio-africana* n. sp., *U. brunnescens* n. sp., *U. dalei* n. sp., *U. spilotoides* n. sp., *U. amaniensis* n. sp.]

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ERICHSEN, C. F. E. Flechtenflora von Nordwestdeutschland. xxiv + 411 *pp.* 1 *map.* 1 *pl.* Gustav Fischer Verlag. Stuttgart. 1957. Price: DM 48.—. [About 777 ssp. New: *Verrucaria aquatilis* f. *vitricola* (Nyl.) n. c.; *Arthopyrenia microspila* f. *pertusariae* (B. de Lesd.) n. c.; *Calicium sphaerocarpum* f. *trachelinum* (Ach.) n. c., f. *epiphloeum* (Ach.) n. c.; *C. abietinum* f. *glaucellum* (Ach.) n. c., f. *pumilum* (Krph.) n. c., f. *minutum* (Kbr.) n. c.; *C. lenticulare* f. *brachypus* (Jatta) n. c., v. *chlorodes* (Nyl.) n. c.; *Sphacophorus globosus* v. *congestus* (Lamy) n. c.; *Opegrapha vulgata* v. *abbreviata* (Kbr.) n. c.; *O. lichenoides* f. *chlorina* (Pers.) n. c., v. *populina* (Moug.) n. c.; *Graphina anguina* f. *diffusa* (Leight.) n. c., f. *divaricata* (Leight.) n. c., f. *flexuosa* (Leight.) n. c.; *Lecidea glomerulosa* f. *achrista* (Smf.) n. c., f. *tabescens* (Kbr.) n. c.; *L. cinereoatra* f. *tegularis* (Sanst.) n. c.; *L. humosa* f. *confluens* (Schaer.) n. c., v. *chthonoblastes* (A. Br.) n. c., v. *ochracea* (Erichs.) n. c.; *Catillaria lenticularis* v. *atomarioides* (Müll. Arg.) n. c.; *C. synothea* v. *poliococca* (Nyl.) n. c.; *C. globulosa* f. *fuscopallescens* (Nyl.) n. c.; *C. prasina* f. *ocelliformis* (Branth. & Rostr.) n. c.; *Bacidia sabuletorum* f. *subsphaerioides* (Nyl.) n. c.; *Rhizocarpon distinctum* f. *dendri-*

ticum (Erichs.) n. c.; *Pycnothelia papillaria* f. *chthonoblastes* (Erichs.) n. c.; *Lecanora albescens* v. *deminuta* (T. Fr.) n. c.; *L. carpinea* f. *cinerella* (Flk.) n. c.; *L. varia* v. *betulina* (Ach.) n. c.; *Ochrolechia androgyna* v. *albosorediosa* (Gyel.) n. c.; *O. bahusiensis* f. *roseo-sorediosa* (Gyel.) n. c.; *Parmelia tubulosa* v. *farinosa* (Hillm.) n. c.; *P. physodes* v. *pseudofarinacea* (Anders) n. c.; *P. conspersa* f. *laciniatula* (Erichs.) n. c.; *P. mougeotii* v. *reagens* (Hillm.) n. c.; *P. furfuracea* f. *nuda* (Ach.) n. c.; *P. acetabulum* v. *microphylla* (B. de Lesd.) n. c.; *P. isidiotyla* f. *glomellifera* (Nyl.) n. c., f. *dissecta* (Hilitz.) n. c.; *Cetraria pinastri* f. *trabinella* (Hepp) n. c.; *Usnea dasypoga* v. *hirtella* (Arn.) n. c.; *U. comosa* v. *glaucina* (Mot.) n. c., v. *similis* (Mot.) n. c., v. *sordidula* (Mot.) n. c.; *U. hirta* f. *minutissima* (Mer.) n. c.; *Cornicularia tenuissima* f. *edentula* (Ach.) n. c., f. *alpina* (Schaer.) n. c.; *C. muricata* v. *sorediella* (Erichs.) n. c.; *Ramalina capitata* v. *paulula* (Erichs.) n. c.; *R. fastigiata* f. *nervosa* (Nyl.) n. c., v. *sorediata* (Erichs.) n. c.; *Caloplaca citrina* f. *leprosa* (Flag.) n. c.; *Buellia punctata* v. *litoralis* (Erichs.) n. c. To be reviewed in the next issue of THE BRYOLOGIST.]

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HEINEMANN, P. Les landes à Calluna du district picardo-brabançon de Belgique. Vegetatio 7(2): 99-147. 14 *fig.* 6 *photos.* 13 *tab.* 1956. [15 *Cladoniae.*]

HILLMANN, J. & V. GRUMMANN. Kryptogamenflora der Mark Brandenburg und angrenzender Gebiete. Band VIII: Flechten. x + 898 *pp.* 45 fig. Gebrüder Borntraeger. Berlin-Nikolassee. 1957. Price: about $20.00. [About 422 spp. New: *Opegrapha rufescens* f. *rubella* (Flot.) Grumm. n. c.; *Graphis scripta* v. *fraxini* (Pers.) Grumm. n. c.; *Peltigera spuria* f. *sorediata* (Schaer.) Grumm. n. c. and its subf. *glabrescens* (Gyel.) Grumm. n. c.; *P. polydactyla* v. *polydactyloides* f. *canariensis* (Gyel.) Grumm. n. c.; *P. horizontalis* f. *parisiensis* (Gyel.) Grumm. n. c.; *Rhizocarpon umbilicatum* f. *subconcentricum* (Schade) Grumm. n. c.; *Cladonia pleurota* f. *extensa* subf. *discifera* (Sandst.) Hillm. n. c., subf. *coronata* (Sandst.) Hillm., f. *lateralis* (Schaer.) Hillm.; *C. gracilis* v. *chordalis* f. *leucochlora* subf. *albinea* (Sandst.) Hillm. n. c., f. *cribrosa* (Flot.) Hillm. n. c.; *Pertusaria coccodes* v. *coccodes* f. *farinosa* (Erichs.) Grumm. n. c., v. *phymatodes* f. *tristicolor* (Erichs.) Grumm. n. c., v. *coronata* f. *exilis* (Erichs.) Grumm. n. c.; *P. amara* f. *diffusa* (Erichs.) Grumm. n. c., f. *myrmecina* (Erichs.) Grumm. n. c.; *P. globulifera* v.

discoidea f. *minor* (Erichs.) Grumm. n. c., v. *corallina* f. *granosa* (Erichs.) Grumm. n. c., f. *subglobulifera* (Erichs.) Grumm. n. c. *Lecanora viridula* (Flk.) Hillm. n. c.; *L. varia* f. *pityrea* (Erichs.) Grumm, n. c.; *L. saligna* v. *sarcopis* (Ach.) Hillm. n. c.; *Parmeliopsis aleurites* f. *diffusa* (Hillm.) Grumm. n. c., v. *pityreiformis* (Bartl. & Hampe) Grumm. n. c.; *Parmelia isidiotyla* f. *pruinosa* (And.) Grumm. n. c., f. *grisea* (And.) Grumm. n. c.; *P. subargentifera* f. *conspurcata* (Schaer.) Grumm. n. c.; *Cornicularia aculeata* v. *spadicea* f. *edentula* (Oliv.) Grumm. n. c., v. *muricata* f. *inermis* (Harm.) Grumm. n. c., f. *crinita* (Zahl.) Grumm. n. c., f. *sorediella* (Erichs.) Grumm. n. c.; *Usnea hirta* v. *minutissima* (Mer.) Hillm. n. c.. *U. dasypoga* v. *melanopoga* (Mot.) Grumm. n. c.; *Caloplaca* subgen. Tetrophthalmium (Müll. Ag.) Hillm. n. c.; *C. decipiens* v. *compacta* (Malbr.) Hillm. n. c.; *Buellia aethalea* f. *baltica* (Erichs.) Grumm. n. c., f. *sororioides* (Erichs.) Grumm. n. c.; *Physcia* subgen. Hypomelaena (Trev.) Hillm. n. c., subgen. Tetramelaena (Trev.) Hillm. n. c., subgen. Hyperphyscia (Müll. Arg.) Hillm. n. c. To be reviewed in the next issue of THE BRYOLOGIST.]

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[PAKHUNOVA, V. G.][3] [Lichen flora of Pacha-Lechkhumi.] [Trudy Tbilisskogo Bot. Inst.] [Tbilisi] 18: 139-180. 1956. [150 spp.]

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[3] Names and title transliterated and translated respectively from the Russian.

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PRESTHEGGE, K. Hva husdyrforsøkene viser om laven som fôr og i ernaering. Naturen [Bergen] 1956(2): 113-128. 2 *diagrams.* 3 *fig.* 1956 [Lichens as fodder.]

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SCOTT, G. D. Lichen terminology. Nature 179: 486-487. 1957. [The algae in lichens should be called "phycobionts," the fungi "mycobionts."]

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TAMM, C. O. Growth, yield and nutrition in carpets of a forest moss (*Hylocomium splendens*). Meddel. från Stat. Skogsforskningsinst. 43(1): 1-140. 45 *fig.* 28 *tab.* 1953. [A few lichens mentioned. Many ecologic data on the environment of *Hylocomium.*]

TOBOLEWSKI, Z. & K. GLANC. Zielnik Porostów Polski. Fasc. VIII. Nr 151-175. Porosty Bieszczadów Zachodnich. [Lichenotheca Polonica. Fasc. VIII. Nr 151-175. Lichenes in montibus "Bieszczady Zachodnie" collecti.] 9 *pp.* (Acad. Sci. Polon.) Poznan. 1957. [Labels for nos. 151-175 in this exsiccata.]

[TOMIN, M. P.][3] [Determination of the Crustose Lichens of the European Part of the U.S.S.R.] 532 *pp. illus.* [Izdatel'stvo, Akademii Nauk Belorusskoi SRR.] Minsk. 1956. Price: 16 rubles. [767 spp. New: *Arthopyrenia bukowinensis* (Makarevicz) n. c., *Thelococcum polysporum* (Tomin) n. c., *Lecanora lacunosa* (Mer.) n. c., *L. terrestris* (Tomin) n. c., *Rinodina sareptana* (Tomin) n. c. To be reviewed in the next issue of THE BRYOLOGIST.]

VĚZDA, A.. Československé druhy rodu *Thelopsis* Nyl. (Lichenes). [Die tschechoslowakischen Arten der Flechtengattung *Thelopsis* Nyl.] Sbor. Vysoké Školy Zemědělské a Lesnické v Brně, Rada C: Spisy Fak. Lesnické 1957(1): 27-42. 3 *fig.* 1957. [4 spp. New: *T. melathelia* v. *lomentispora* n. v. German and Russian summaries.]

———. Lichenes Bohemoslovakiae Exsiccati, Editi ab Instituto Botanico Universitatis Agriculturae et Silviculturae. Brno, ČSR. Fasciculus II. Dec. 4-6 (1957). 8 *pp.* [Labels for nos. 31-60 in this exsiccata.]

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Universitatis Agriculturae et Silviculturae, Brno, ČSR, Fasciculus III. Dec. 7-9 (1957). 8 *pp.* [Labels for nos. 61-90 in this exsiccata.]

[Vilenskii, D. G.][3] [Soil Science.] 456 *pp.* 124 *fig.* [Gosudarstvennoe, Uchebno-Pedogogicheskoe, Izdatl'stvo, Ministerstva Prosveshscheniia, RSFSR.] Moscow. 1954. [Lichens: pp. 74-75, 229.]

Wachtmeister, C. A. Studies on the chemistry of lichens X. The structure of porphyrilic acid. Acta Chem. Scand. 10: 1404-1413. 1956. [*Haematomma coccineum* (Dicks.) Kbr.]

[Weatherby, C. A.] Lichens. 1 *p. in* H. J. Arnold & S. W. Bailey, "Bartholomew's Cobble, Sheffield, Massachusetts." *32 unnumbered pp. illus.* [Bartholomew's Cobble Reservation.] n. d. [1957?]. [30 spp.]

NEWS AND NOTES

Miss Nieva Veloira (Dept. of Botany, University of Tennessee, Knoxville) wishes to know the location of all Philippine moss collections in North America, no matter how small. She needs the information for a supplement to Bartram's *Manual of Philippine Mosses* which she is preparing as a part of a master's thesis.

Albert Koelling (M.S., Univ. of Illinois, 1957) will be a graduate assistant at the University of Tennessee this year and will work toward a Ph.D. in some phase of bryology.

At the University of Michigan Biological Station this summer, A. J. Sharp had four students in bryology, six in lichenology and four in bryological research. Nieva Veloira of the Philippine Islands and Zennoske Iwatsuki of Japan were both at the Station. Iwatsuki will complete his Master's degree at the University of Tennessee in January, on correlations between the bryofloras of Japan and eastern North America, and will leave for home either in January or April.

Margaret Fulford was recently made one of 13 Fellows of the Graduate School of Arts and Sciences at the University of Cincinnati. This appointment will relieve her of teaching responsibilties and make it possible for her to devote full time to the completion of an hepatic flora of tropical America.

Jennifer Wootton will assist W. C. Steere in his research at Stanford University this year. Miss Wootton studied bryophytes under E. V. Watson at Redding University and taught at Western College for Women at Oxford, Ohio, last year.

William Culberson has been working on the taxonomy and biochemistry of *Parmelia*, with financial support from the Lalor Foundation.

The following received Ph.D. degrees from Florida State University, August 10, 1957: Paul L. Redfearn (A Study of Bryophytic Associations Occurring on Calcareous Substrates in Florida; position: Associate Prof. of Biology, Southwestern Missouri State College, Springfield); Wm. D. Reese (The Genus *Calymperes* in North America; position: Assistant Prof. of Biology, Southwestern Louisiana Institute, Lafayette); Ronald A. Pursell (A Taxonomic Revision of North American *Fissidens*, section Bryoideum; position: Acting Assistant Prof. of Biology, Univ. of Colorado, Boulder). Pursell will replace Wm. A. Weber during the latter's stay

in Europe and will be in charge of the herbarium.

WM. WEBER will make his headquarters during this year at the Botaniska Avdelningen, Naturhistoriska Riksmuseet, Stockholm (rather than at Oslo, as previously announced).

HAROLD BOLD, whose textbook on plant morphology has recently been published, has moved from Vanderbilt Univ. to the Univ. of Texas at Austin.

RONALD MCGREGOR has been made Chairman of the Dept. of Botany, University of Kansas.

LES VIERECK, who spent the summer of 1956 with Wm. Weber in Mt. McKinley National Park, collected in Alaska again this summer on an IGY assignment.

SAM SHUSHAN spent the summer collecting lichens in Colorado, New Mexico and Arizona.

JOHN ERSKINE (Wolfville, Nova Scotia) spent part of the summer in archeological exploration in the Maritime Provinces. MARGARET FULFORD visited Roan Mt. at Rhododendron time. WINONA WELCH toured eastern Canada in the summer and visited the National Museum of Canada and as well as the Agricultural School at Rimouski where she met FATHER LEPAGE. JASMINE MCKECHNIE (Ottawa) spent a vacation on Deer Isle, Maine, near Bar Harbor. ELVA LAWTON studied the Nevada specimens of mosses at the U. S. National Herbarium, and H. L. BLOMQUIST visited Florida State University in connection with the portion on *Sphagnum* which he is contributing to RUTH BREEN'S manual of Florida mosses.

GENEVA SAYRE will be on leave of absence from Russell Sage College during the academic year. She has received support from the National Science Foundation for the preparation of a critical bibliography of bryological publications between 1801 and 1821. She plans to spend about six months in American libraries and four in Europe. During the past summer she continued her work on the Grimmiaceae.

DONALD P. ROGERS has resigned as Curator of Cryptogams at the N. Y. Botanical Garden to accept a position at the University of Illinois as Professor of Botany and Curator of the Mycological Collections.

WILLIAM C. STEERE resigned from his duties as Editor of the *American Journal of Botany* on Sept. 1 and was succeeded by HARRY J. FULLER.

HOWARD CRUM and WILFRED SCHOFIELD found some 200 species of mosses in the arid mountains of southwestern Yukon. *Stegonia pilifera* was found very abundantly in many habitats, all far removed from the usual maritime situations. *Trematodon brevicollis, Bryobrittonia pellucida* and *Splachnum luteum* were among the many interesting finds. The phanerogamic flora was exceedingly rich and yielded more than 400 species including about 60% of the arctic species known from the Canadian Arctic Archipelago. Schofield will be at Duke University this year working toward a Ph.D. in ecology. EDDIE KLEBSCH and HAROLD ROBINSON will also be graduate students at Duke.

A new list of members of the society will appear in the December *Bryologist*. Please inform the editor of any address changes or corrections.

The annual report of the secretary, DR. L. J. GIER, shows a membership of 435 persons, or an increase of 12 over last year and 31 over two years ago. (Unfortunately, 26 members

are delinquent in paying their subscriptions.) The treasury has a balance on hand of $9,942.46, as of Aug. 1. This includes $5,850 from the National Science Foundation as a grant-in-aid of the 60-yr. index to *The Bryologist*. Since expenditures during the past year were only $1,899.30, it appears that the society will have a comfortable financial margin for the next year and for the first time in many, many years!

WANTED TO BUY: Parts I and IV of Grout's *Mosses with Hand-lens and Microscope* (or a complete, bound copy). A new, enthusiastic student. Please write Mrs. ELIZABETH M. DUNHAM, *22* Birch Rd., Wellesley 81, Mass. Mrs. Dunham would also like to find a complete set for herself, as she has worn out her own copy from long usage.

M. SUZANNE JOVET-AST (Muséum National d'Histoire Naturelle, Paris), in preparation of a monograph, wishes to receive named or unnamed specimens of *Riccia* from all over the world.

The Ninth International Botanical Congress will be held in Montreal, Canada, from August 19 to *29*, 1959, at McGill University and the University of Montreal. The program will include papers and symposia related to all branches of pure and applied botany. A first circular giving information on program, accommodation, excursions, and other detail will be available early in 1958. This circular and subsequent circulars including application forms will be sent only to those who write to the Secretary-General asking to be placed on the Congress mailing list: DR. C. FRANKTON, Secretary-General, IX International Botanical Congress, Science Service Building, Ottawa, Ontario, Canada.

HENRY A. IMSHAUG has received an NSF grant for a three-year study of the lichens of the West Indies, the objective being a manual treatment of the lichen flora. The summer of 1958 will be spent in Cuba and the summer of 1959 in Hispaniola. Dr. Imshaug would be glad to receive West Indian lichen material for identification.

Word has been received that G. O. K. SAINSBURY of New Zealand died in July. In 1955 Mr. Sainsbury completed his *Handbook of the New Zealand Mosses* and in 1956 became a Fellow of the Royal Society of New Zealand.

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THE HEPATIC EXCHANGE

Beginning January 1, 1939, this Exchange has been operated under the same rules as The Moss Exchange. Privileges are available only to members of the American Bryological Society who have paid annual dues of 25c to Dr. Leo F. Koch, Herbarium, 350 Natural Science Bldg., University of Illinois, Urbana, Ill. Only fully determined specimens in packets with complete data will be accepted. It is suggested that there be at least five packets of each species with an extra which will be forwarded to the Curator of Hepatics for the American Bryological Society Hepatic Herbarium. All material for determination should be sent to the Curator of Hepatics, Dr. Margaret Fulford, Department of Botany, University of Cincinnati, Cincinnati, Ohio.

THE MOSS EXCHANGE

As announced in The Bryologist **38**: 100, Sept.-Oct., 1935, there is now an exchange for mosses. This exchange is available to members of the American Bryological Society upon payment of annual dues of 25c to Dr. E. H. Ketchledge, Dept of Forest Botany, State College of Forestry, Syracuse 10, New York. Only fully identified specimens in packets with complete data on them should be sent in. It is suggested that there be five or more packets of each species.

These two exchanges offer an excellent opportunity for A.B.S. members to build up their own herbaria of choice, well-labelled specimens.